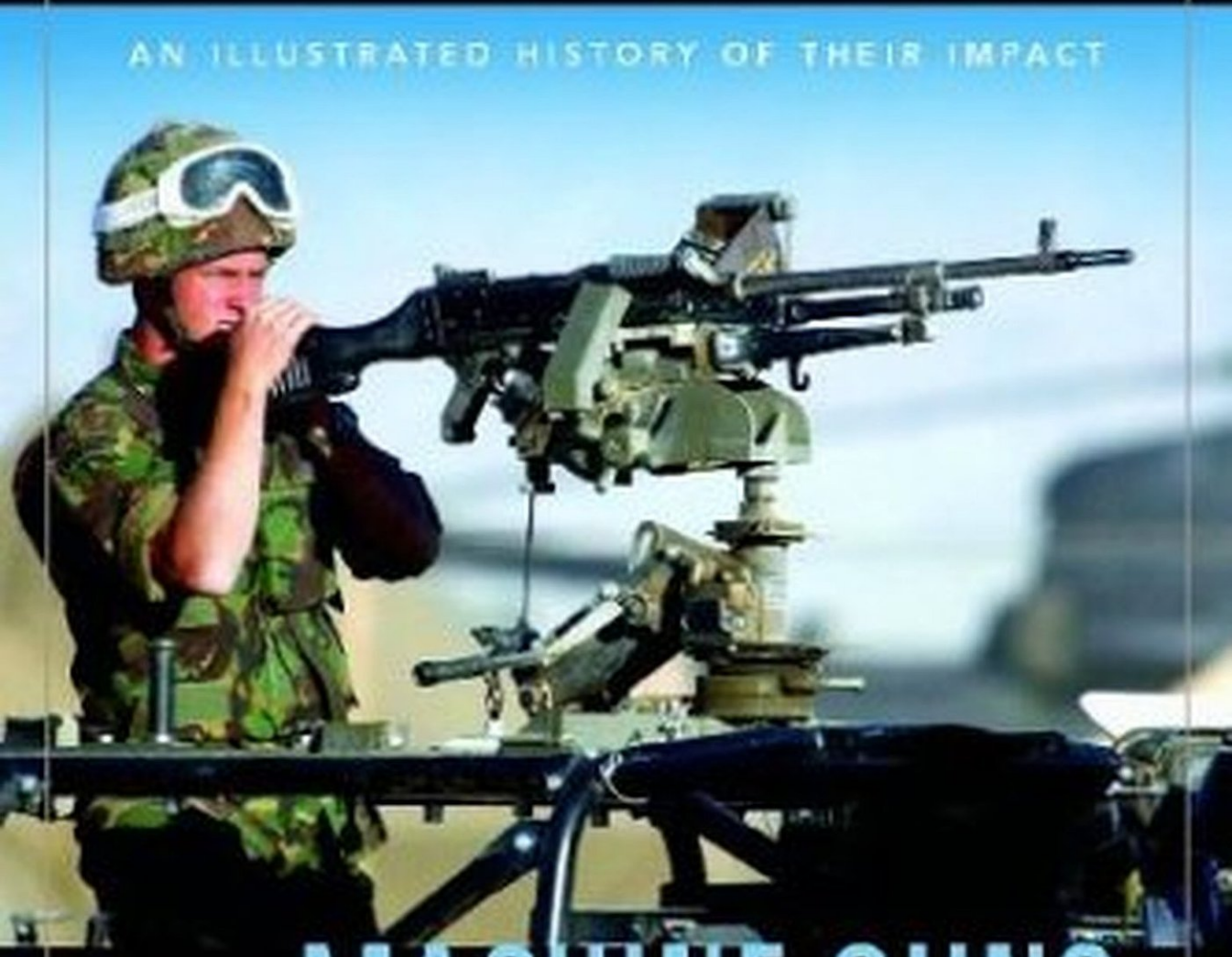
WEAPONS AND WARFARE

AN ILLUSTRATED HISTORY OF THEIR IMPACT



MACHINE GUNS

JAMES H. WILLBANKS

MACHINE GUNS

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James H. Willbanks

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Santa Barbara, California Denver, Colorado Oxford, England

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INTRODUCTION TO WEAPONS AND WARFARE SERIES

Weapons both fascinate and repel. They are used to kill and maim individuals and to destroy states and societies, and occasionally whole civilizations, and with these the greatest of man's cultural and artistic accomplishments. Throughout history tools of war have been the instruments of conquest, invasion, and enslavement, but they have also been used to check evil and to maintain peace.

Weapons have evolved over time to become both more lethal and more complex. For the greater part of man's existence, combat was fought at the length of an arm or at such short range as to represent no real difference; battle was fought within line of sight and seldom lasted more than the hours of daylight of a single day. Thus individual weapons that began with the rock and the club proceeded through the sling and boomerang, bow and arrow, sword and axe, to gunpowder weapons of the rifle and machine gun of the late nineteenth century. Study of the evolution of these weapons tells us much about human ingenuity, the technology of the time, and the societies that produced them. The greater part of technological development of weaponry has taken part in the last two centuries, especially the twentieth century. In this process, plowshares have been beaten into swords; the tank, for example, evolved from the agricultural caterpillar tractor. Occasionally, the process is reversed and military technology has impacted society in a positive way. Thus modern civilian medicine has greatly benefited from advances to save soldiers' lives, and weapons technology has impacted such areas as civilian transportation and atomic power.

Weapons can have a profound impact on society. Gunpowder weapons, for example, were an important factor in ending the era of the armed knight and the feudal age. They installed a kind of rough democracy on the battlefield, making "all men alike tall." We can only wonder what effect weapons of mass destruction might have on our own time and civilization.

This series will trace the evolution of a variety of key weapons systems, describe the major changes that occurred in each, and illustrate and identify the key types. Each volume begins with a description of the particular weapons system and traces its evolution while discussing its historical, social, and political contexts. This is followed by a heavily illustrated section that is arranged along chronological lines that provides more precise information on at least 80 key variants of that particular weapons system. Each volume contains a glossary of terms, a bibliography of leading books on that particular subject, and an index. Individual volumes in the series are each written by a specialist in that particular area of expertise.

We hope that this series will be of wide interest to specialists, researchers, and even general readers.

Spencer C. Tucker
Series Editor

PREFACE

This is a book that traces the history and development of the machine gun, a weapon that changed warfare starting with its introduction during the U.S. Civil War in the mid-1800s. Its fullest impact, however, would be experienced by forces of the Western Allies in Europe 75 years later, during World War I. That is where our story begins.

THE BATTLE OF THE SOMME

In July 1916, the British Expeditionary Force launched a massive counteroffensive against the Germans in the vicinity of the Somme River on the Western Front. Known as the Big Push, it was timed to coincide with major attacks by the Russians and the Italians on their fronts—a three-pronged attempt to break the stalemate of trench warfare and force Germany and Austria-Hungary into submission.

On 25 June, the British began preparing the way for the impending attack along the Somme with a massive five-day artillery bombardment meant to soften up the Germans, who waited across no-man's land in strongly built defensive positions. The British generals were confident that the artillery would pulverize the defenders and expected their troops to march steadily over the German positions once the attack was launched.

At 7:30 A.M. on 1 July, the British officers blew their whistles and 66,000 men went over the top. They moved steadily toward the German lines; one company of the 8th East Surreys symbolized the kickoff of the offensive by booting soccer balls toward the German trenches as they advanced. The German soldiers, however, had survived the shelling and rushed from their dugouts to man machine

gun posts all along the front. The result was disaster for the attacking British. German gunners, manning previously zeroed-in Maxim machine guns, mowed down battalions of British infantry in minutes as German artillery pounded the attackers. A German gunner wrote after the first day of battle:

> We were amazed to see them walking, we had never seen that before.... The officers were at the front. I noticed one of them was strolling along, carrying a walking stick. When we started firing we just had to load and reload. They went down in the hundreds. We didn't have to aim, we just fired into them.[1]

Some assault battalions did not even clear their own lines before they were cut down by the Maxims' fatal stutter. By the end of the first hour, only 30 percent of the 84 assaulting battalions were anywhere near their objectives. The rest were either pinned down by the German gunners or had already been wiped out by the Maxim guns. It was estimated that 50 percent of the force employed in the first wave had fallen. Nevertheless, the British high command continued to throw in reinforcements until more than 100,000 soldiers had been committed. By the time the fighting ended, it marked the blackest day in British military history. More than 60,000 soldiers of the British Empire littered the field, dying men trapped in the beaten zone, burdens for the stretcher-bearers, or walking wounded.[2] Of 129 British battalions committed to the battle, 32 lost more than 500 men each. Worst-hit of all: the 10th West Yorks, in which 710 men fell.[3]

The Battle of the Somme demonstrated the devastating effect of the modern machine gun and forever changed the face of battle. The first machine guns were developed in the nineteenth century, but the weapon came into its own during World War I, taking a murderous toll on both sides. Since that time, the machine gun has become one of the mainstays of armies all over the world.

OUTLINE OF THE BOOK

The purpose of this book is two fold: first, to explore the early development and evolution of the machine gun and submachine guns (SMGs) as weapons systems; and second, to provide a reference that will focus on the significant machine guns and submachine

guns of the world, including both the early types and those of contemporary times.

The eight chapters begin with a discussion of the history of the machine gun in Chapter 1, an examination of the evolution of small arms and ammunition from the earliest cannons through repeating weapons technology that set the stage for the development of machine guns. In Chapter 2, the focus shifts to early attempts to devise a mechanical machine gun, with emphasis on the Gatling gun. Chapter 3 looks at the development of the Maxim machine gun, the first automatic machine gun. Chapter 4 addresses the seminal role played by the machine gun during World War I. Chapter 5 examines modifications in machine-gun technology that resulted in the development of submachine guns. Chapter 6 discusses technological developments during the interwar period. Chapter 7 looks at the role of the machine gun during World War II. And Chapter 8 addresses developments during the Cold War years. The second half of Chapter 8 concludes with a look at the future of the machine gun.

The rear matter includes the reference materials and technical data. Each entry includes a description of the weapon system, as well as characteristics and pertinent data. The intention here is to highlight the most important weapons developed from the earliest days to contemporary times.

NOTES

1 Quoted in Anthony Smith, *Machine Gun: The Story of the Men and the Weapon That Changed the Face of War* (New York: St. Martin's Press, 2002), p. viii.

2 S. L. A. Marshall, *The American Heritage History of World War I* (New York: American Heritage, 1982), p. 180.

3 Ibid.

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MACHINE GUNS

CHAPTER 1

Introduction: The Search for Firepower

The history of military small arms can be traced from the hand cannon to the gas-operated assault rifle. Without the development and improvement of these weapons, the modern machine gun would not have been possible. Therefore, before discussing the history of machine guns, we first consider the general evolution of military small arms, particularly shoulder weapons. There is a lot of uncertainty in the study of the history of weapons, particularly firearms. One historian suggests two reasons: First, until roughly the turn of the twentieth century, few historians paid attention to the evolution of firearms; second, few historians have much to say about the part played by weapons in world history.[1] The result is that records and documentation on the earliest days of weapons development are scarce. Therefore, it is difficult to precisely say when some developments and inventions occurred. Another problem is that the process has not been completely linear, that is, the evolution has not been step-by-step, in which one development leads logically to the next. The history of firearms is one of inventors, gunsmiths, and tinkerers all over the world working on their own ideas. Some discoveries were made nearly simultaneously in several countries. Some developments were merely modifications to earlier designs. Given the complexity of the history of firearms, the intent here is not to provide a detailed chronological study but rather to examine the most significant developments and trends in military firearms that made possible the evolution of the modern machine gun and had an impact on warfare in general.

GUNPOWDER

From the earliest days of combat between human beings, men have used weapons to try to best each other. First came sticks and clubs, then spears, and eventually swords. A natural progression was a desire to avoid hand-to-hand combat and substitute skill for brawn. This led to the substitution of missiles for manual weapons, first seen in the development of javelins and other throwing weapons such as the sling. A major leap forward was made with the development of the bow and arrow.

Archery flourished in Europe between the eleventh and fifteenth centuries. The bow provided the archer with the ability to project an arrow much farther than he could throw a spear. Eventually, the longbow played a major role in the evolution of warfare. However, it had some drawbacks. The strength of the archer was a limitation, and as body armor technology evolved something more was needed that could pierce the knight's iron suit.

The invention of gunpowder (a mixture of charcoal, sulfur, and potassium nitrate) would provide the solution. Few inventions have had such an impact on human affairs as dramatic and decisive as that of gunpowder; it changed all that went before and revolutionized weapons development. When and where gunpowder was invented is subject to debate. It is almost certain that gunpowder had been known as early as the A.D. ninth century in China, where it was applied to pyrotechnics, the blasting of rocks, and other useful purposes.[2] It was the Europeans, however, who applied gunpowder to the needs of contemporary warfare beginning at the end of the Dark Ages. Some historians believe that Europeans first acquired gunpowder from the Mongols in the thirteenth century. The actual date of the arrival of gunpowder in Europe cannot be reliably documented. However, it is known that the first recorded mention of gunpowder was by the Franciscan monk Roger Bacon in 1242 in a treatise entitled *De Mirabili Potestate Artis et Naturae* (On the Marvellous Power of Art and Nature). Regardless of the actual date of gunpowder's discovery in Europe, it was a monumental development that would prove to be a major factor in bridging the gap between the medieval and the modern eras. The application of gunpowder to weapons development resulted in a drastic change in the nature of those weapons and, by extension, the evolution of warfare.

The date of gunpowder's first application as a weapon is equally debatable. A German monk, Father Berthold Schwartz of Freiburg-in-Breisgau, more popularly known as Black Berthold, is credited by

some with inventing the first gun by accident in 1320. A longstanding legend says that the monk pounded together a mixture of saltpeter, charcoal, and sulfur in a mortar one day, causing it to explode and blow the pestle out of the vessel. Allegedly, this gave Berthold the inspiration for the invention of a weapon that used gunpowder to propel a missile out of a closed tube. This is a fascinating story, but most historians contend that there is little evidence to suggest that it is true; indeed, some historians believe that Black Berthold himself was as much a legend as that of his famous discovery.[3] Nevertheless, evidence suggests that cannons had appeared on the scene by the first quarter of the fourteenth century.[4]

CANNONS

The first unquestioned reference to the cannon comes in 1326, when Walter de Millimete wrote a treatise for the young Prince Edward, later King Edward III of England (1327–1377), entitled *De Officiis Regnum* (On the Duties of Kings). Millimete included in this manuscript a drawing of what was undoubtedly a cannons. The following year, there is an entry in the records of the city of Florence that alludes to the manufacture and purchase of brass cannon and iron balls for the defense of the city.

One of the first recorded uses of cannons on the battlefield was in August 1327 at the Battle of Weardale, where the victorious English under Edward III used what Archdeacon Barbour of Aberdeen called "crakys of war" against the Scots.[5] There were other documented instances of the use of cannons around this same time. The Germans besieged the Italians at Cividale in Friuti in 1331, using cannons, or what the Italians called *vasa e scioppi*. From this period forward, there is clear and repeated documentary evidence that cannons and gunpowder began to play a major and increasing role in armed conflict.

Development

The emergence of cannons derived from two basic ideas. First, the propellant power of gunpowder could be used most effectively when enclosed within the confines of a tubular barrel. The second idea was that a spherical ball was the optimal projectile. The early can-

nons used these two ideas, which would eventually provide the basis for a steady stream of improvements and modifications that would result in modern artillery and lead to the development of smaller firearms.

The first cannons were crude in comparison to later evolutions of the weapon. They were often shaped like a vase with a flared muzzle, very similar to the mouth of a bell. Because of the state of foundry techniques, the earliest cannons were constructed using a practice that appeared to be drawn from cooperage. Since the foundries of the day were not able to cast a solid single piece of metal of sufficient size, the cannons were often made of bars of iron hooped together with rings like the staves of a barrel. To achieve the proper shape, a wooden core was necessary. Once the bars were banded together around the core, the segments were then welded into a single mass with high heat (the wood was burned by the forging process or removed once the iron cooled). This process produced a tube, or barrel, open at both ends. Because cannons could not be forged as one piece, they were breechloaders by necessity. The major problem with that design was that the open breech end is difficult to seal and more often than not the explosive power of the propellant charge dissipates, decreasing the power of the weapon. The initial answer was to devise a plug that could be inserted into the breech end to achieve a gastight seal. Other solutions involved separate breechblocks that could be mated to the barrel. Over time this basic concept was refined as technological advances were made in design, available materials, and foundry techniques. Eventually, the technology permitted cannons to be forged in one piece with the breech end closed.

The next problem was igniting the gunpowder. A small hole (the touch hole or vent) was drilled in the top of the barrel down into the bore of the barrel. Gunpowder is poured down the open end of the barrel and then a projectile, usually some form of cannonball (first stone and then cast iron), is inserted. The gunpowder and cannonball sit in the breech. A small amount of powder is poured down the touch hole. Fire is then applied to the powder in the touch hole, which in turn ignites the gunpowder in the breech. The charge burns rapidly and produces hot gas. The hot gas applies much greater pressure on the powder side of the cannonball, propelling it out of the gun at a high rate of speed. These principles remained generally constant despite the steady stream of improvements and

modifications made over the ensuing years until modern breech-loading cannons were developed.

From Cannons to Small Arms

This discussion of early cannons is useful to understanding that the gradual reduction in the size of cannons led to the revolution in small arms; the first handheld guns were essentially miniature cannons.[6] One of the first recorded instances of this type of weapon was in 1364 in Perugia, Italy. It was a small lead cannon (1–3 feet in length) fastened to a wooden shaft, or *tiller.* The tiller was held under or over the arm when the weapon was fired or even leaned against the ground or a wall. The weapon was loaded like other cannons, by pouring a charge of gunpowder down the barrel, followed by a *wad,* usually a small bag of rags or straw. The wad was forced into the breech end of the weapon with a ramrod and was meant to seal the powder in the barrel. A ball was then dropped into the muzzle and tamped with the ramrod. The weapon was fired by applying a glowing coal or red-hot firing wire to the touch hole to ignite a small amount of powder that had been poured in the touch hole. The explosion of this powder would flash down the touch hole and ignite the powder in the breech, which in turn would explode and propel the ball rapidly down the barrel and out the muzzle.

If we examine the cannon and the small arms that evolved from it, the principles are the same. The weapon must first be charged with propellant and projectile, it must be directed toward the target, and it must be discharged by igniting the propellant charge. In simpler terms: load, aim, fire. All advances in firearms have derived from attempts to make this process more rapid, efficient, and effective.

SMALL ARMS

The first small arms, like early cannons, were muzzleloaders. One difficulty was igniting the charge. Like their larger cousins, early small arms employed priming powder to ignite the main propellant charge via the touch hole. There were some practical problems: the powder would be dislodged by wind or the slightest motion. One solution was to place the touch hole on the right side of the barrel in-

stead of on top and to attach a small pan that held the priming powder. This kept the powder from being blown away by wind.

Early Models

As hand cannons began to resemble what we now know as rifles, several other problems developed. The shooter was primarily interested in applying the burning brand or red-hot wire to the touch hole and thus had difficulty simultaneously aiming the weapon to ensure an accurate shot. In addition, he had to stay fairly close to a source of fire in order to obtain the burning brand or heat the firing wire. This was not an insurmountable problem for cannons, which stayed relatively stationary during battles and sieges, but it was a major disadvantage for soldiers, who were expected to move about the battlefield. An answer was found around 1400 with the invention of the *slow match,* a twisted rope of hemp or other fiber that had been soaked in a solution of saltpeter so that it would burn slowly and steadily, maintaining a glowing coal, much as a punk does. This gave the shooter freedom to move; he no longer had to stay near a fire source, since the match, once lit, would burn for an extended period.

The next evolution in small arms used this emerging technology to great advantage. In the second quarter of the fifteenth century, the *harquebus* was invented. It is unclear exactly who actually invented the harquebus, because several countries claim credit, and variants were soon in use all over Europe. This light, portable weapon employed several innovations. First, it had a mechanical device that held the match; this device was operated by hand, moving the match up and down, bringing it into contact with the priming powder and firing the weapon. The shooter no longer had to hold the weapon in one hand and the match in the other. The second improvement overcame another problem: the first hand cannons were difficult to aim, with nothing that approximated a handle or stock. The major innovation of the harquebus was its stock, a piece of wood affixed to the barrel to provide a sturdy base by placing the butt of the stock against the chest. This gave the shooter much more control; there was a downside, however, because placing the stock in the middle of the chest led to dangerous recoil effects and reduced accuracy.

The Germans devised the solution by sloping the stock to fit the shoulder. At the same time, they elevated the barrel to bring it inside the range of the shooter's eye. He could now sight along the barrel to the target, greatly improving accuracy. Weapons constructed in

this manner were used in England in the time of Henry VIII; documents reveal that the king placed an order for 500 such weapons in 1511. Other evidence indicates that similar weapons having some form of stock were being developed about the same time throughout Europe. They were variously called *haquebut, hakebut, hagbut,* and *hagbus,* names derived from the hooked shape of the butt. A small-sized harquebus, with a nearly semicircular butt, called a *demi-haque,* was probably the origin of the modern pistol.

The next major advancement was the matchlock, invented in Spain around 1500, beginning with improvements to the hand-fired harquebus. Eventually, a mechanical contrivance was developed whereby an S-shaped metal arm, a *serpentine,* was hinged to the stock; the top end formed a clamp that would hold a piece of the burning match. When the lower end of the holder was pulled, the burning end of the match would fall forward into the pan, igniting the powder that led through the vent into the breech, thus firing the weapon.

This arrangement was soon improved by cutting off the lower half of the serpentine, putting a spring behind it to force the match-holder toward the vent, and then fitting a stop, controlled by a trigger, to hold the match away from the pan until ready to fire. Eventually, the extension of the trigger, the spring, and other associated mechanisms were placed inside the woodwork and protected from the elements; collectively, this mechanism became known as the lock. The improved version of the harquebus concept soon came to be called the matchlock.

The matchlock *mosquetes* (muskets) fielded by Spanish infantry were introduced first in France and then England. At first the musket weighed as much as 25 pounds, and the musketeer was usually accompanied by an assistant who helped carry it. It eventually came to weigh less, but it was still so heavy that it had to be fired from a rest—a shoulder-high staff—pointed at the lower-end, with an iron fork in which the musket barrel was laid down.

Aside from weight, the matchlock's major disadvantage was that the musketeer had to keep the match lit and ready for use for long periods. This could prove to be difficult depending on weather conditions; rain and wind could render the match useless. When lit, the match was always a safety hazard in the presence of gunpowder. In addition, the match was visible at night, revealing the location of the musketeer. Despite the disadvantages, the matchlock remained the standard military firearm in Europe for more than 150 years.

Still, inventors continued to explore new ideas for ignition. They eventually arrived at the use of pyrites. This mineral substance, a

natural combination of sulfur and iron, had been known for centuries for its quality of making sparks. Applied to weapons technology, it provided an answer to the problems of the matchlock.

The firelock, named for its production of fire by friction, was the first improvement upon the matchlock and took full advantage of pyrites. One of the earliest forms of this weapon, known as the wheel lock, was invented in Germany around 1517. The main part of the lock was a small, serrated wheel that was attached, via a short chain of three links, to a powerful leaf spring made of steel. Using a wrenchlike tool called a spanner, the firer cranked this wheel counterclockwise, drawing up the spring until the wheel engaged a catch linked to the trigger. When the trigger was pulled, the spring released, which caused the wheel to whirl around at great velocity to strike a piece of iron pyrite, producing a shower of sparks through the friction of stone and steel. At the same time, the mechanism also automatically retracted a lid covering the pan so that the sparks were directed downward causing the priming powder to explode, igniting the gunpowder in the breech.

Some wheel locks contained more than 50 separate parts and were complex. Nevertheless, the wheel lock was reliable if maintained and seldom misfired. They were much more dependable than the matchlock, were safer because accidental discharge was less likely, surer in all weather conditions, and easier to handle. Since there was no need to hold a burning match in the nonfiring hand, guns could be managed with only one hand, making the pistol a practical possibility. The wheel lock was also applied to smaller, shoulder-fired weapons that could be used by cavalry soldiers. However, because of the complexity of the weapon, difficulty in maintaining the delicate wheel lock mechanism in good operating order, and the high cost of manufacture, the wheel-lock musket never supplanted the matchlock as the standard military arm.

The next major improvement came from Spain. At the beginning of the seventeenth century, the Spanish developed the *miquelet* lock (or Spanish lock), which combined the simplicity of the matchlock with the spark ignition of the wheel lock. The iron pyrites used in the wheel lock were very soft and wore out quickly. The answer was common flint, which also produced sparks when struck with metal but was much more durable than pyrites. The Spanish used the basic idea of the wheel lock but substituted flint for the pyrites and made some major changes to the lock. The *miquelet* lock consisted of the flint, held in a small vise, called a cock, and a new component, a flat piece of steel, furrowed like the edge of the wheel in the

wheel lock, which was screwed on the barrel beyond the priming pan in such a manner as to be movable. By bringing this piece, called a *frizzen,* over the pan and pulling the trigger, the cock was released, pivoting around its pivot and bringing the flint in the cock into contact with the vertical face of the frizzen, producing a shower of sparks. This action also knocked the cover of the pan forward so that sparks fell on the priming powder in the pan, firing the gun.

Around the same period, the Dutch came up with a similar design. Around 1600, there was in Holland a band of marauders known as *snaphausen,* or "poultry-stealers." They were not able to afford the expensive wheel locks, and the matchlock exposed them at night during their depredations. Therefore, they came up with a new lock that was, according to some historians, an adaptation of the principles used in the Spanish lock. The result was called the *snaphance,* or *snaphaunce*.[7] This lock was very similar to the *miquelet* lock but employed an internal spring and tumbler arrangement that made it simpler to operate. The simplicity and cheapness of this lock soon made it commonplace and set the stage for the transition from matchlock to flintlock.

The flintlock drew heavily on the technology that went before it; some historians maintain that it was not a new invention but rather a refinement and improvement over earlier ideas like the Spanish lock and the Dutch snaphaunce. It is generally thought that Marin le Bourgeoys, a French gunsmith from the town of Lisieux in Normandy, was the father of the flintlock. He combined the best features of the older spark-striking systems to produce a new weapon that would dominate battlefields for years to come. He used the traditional striking wheel and pan cover but modified the inner working of the cocking mechanism to permit a safety, or half-cocked, position as well as a full-cock that could be released smoothly and quickly by the pull of the trigger.

Le Bourgeoys's flintlock design was brought to Paris, where pattern books were published in the 1630s. The flintlock contains fewer delicate parts, is cheaper to manufacture, and is easier to repair than the wheel lock. Over the ensuing thirty years, the flintlock was manufactured in great numbers in Europe and appeared in the New World. Between 1650 and 1700, the flintlock supplanted both the matchlock and the wheel lock as the standard infantry weapon in most armies of the world.[8] It was a great leap forward in simplicity, reliability, and safety, becoming what one historian described as a "handmaiden of history," playing a decisive role in events that shaped the world.[9] They were "used to fight the great wars of the eighteenth

century, wars that determined monarchs to rule Spain and Austria and that established France as the leading power on the continent"; in North America, British and French troops used them to fight for control of a colonial empire, and Americans used flintlocks to gain freedom during the Revolutionary War; in Europe flintlock muskets "brought the French and English rivalry to its climax at Waterloo."[10] Throughout these tumultuous years and tremendous struggles, the flintlock played a key role in the armies of the major powers.

Once the flintlock was perfected, firearms became more common. The cheaper and simpler flintlock lowered the price and reduced the workmanship required (all early firearms were expensive, essentially handmade products by skilled craftsmen). The flintlock technology was also applied to all sorts of guns, from muskets to blunderbusses to dueling pistols, Kentucky rifles, and even eventually revolvers. Since the flintlock arrived on the scene at the start of industrialization, weapons production became one of the first industrial sectors to exploit the transition from craft production to the large-scale production of the Industrial Revolution. On the military side, these weapons entered service while the scale of ground forces employed in battle was increasing. The ability to manufacture large numbers of muskets enabled military leaders to equip these mass armies. When the American Revolution began, the muskets employed were very similar, whether used by American, British, French, or German troops. They were large-caliber flintlocks with smooth bores. The soldier used a prepared paper cartridge containing a ball and a measured charge of powder, ready for instant use. To load, the soldier poured a little powder into the flash pan, dumped the rest down the barrel, and followed it with the ball and the remnant of paper to serve as a wad. A ramrod was necessary to make sure that the ball seated firmly. Using such cartridges, a well-trained soldier could load and fire the musket with remarkable speed. The smoothbore musket was widely used and proved time and again, during numerous battles and wars, to be deadly efficient when used in numbers against massed bodies of men.

IMPROVEMENTS IN AMMUNITION AND ACCURACY

The next leap came around 1800 in Scotland. The Reverend Alexander John Forsyth, an ardent hunter, became frustrated when he kept

missing the ducks at which he was shooting. The ducks could see the flash from the priming of his flintlock fowling piece, and the few seconds between the flash and the firing of the main charge alerted the birds, giving them time to evade the shot. The reverend first tried installing a hood over the lock to hide the flash. This worked, but it was awkward. Forsyth sought some way to eliminate the free sparks and the flash altogether.

Forsyth had read that chemical substances made by dissolving metals in acid, called fulminates, explode when struck sharply. After several years of trial and error, he developed a workable percussion lock. This lock, called a scent-bottle lock, employs a container for the fulminates that looks like a perfume bottle; rotating this bottle forward releases fulminate powder into the pan. When the trigger is pulled, the hammer strikes the fulminate directly so that the full force of the fulminate explosion is projected through the vent to ignite the charge inside the breech. This weapon fires instantly without the normal delay between the firing of the priming charge and the main charge. A number of inventors developed variations on percussion ignition. The most important advance came in 1815, when a Philadelphian named Joshua Shaw invented percussion caps. This is a small metal (usually copper) capsule that contains a small amount of fulminate inside its crown; this capsule is fitted onto a steel nipple mounted at the weapon's breech, and a small channel in the nipple communicates the flash from the cap to the powder chamber. By 1830, percussion caps had become the most widely accepted system for igniting firearm charges. However, it was really Forsyth's application of fulminates, although developed for the sporting gun, that paved the way for what followed.

Rifling and the Minié Ball

The main drawback of the smoothbore flintlock was its limited range and accuracy. It could deliver a heavy, round ball that could crush bones and destroy tissue at close range, but even the best marksman had difficulty hitting a target beyond 75 yards. When fired in a volley, the flintlock could still produce casualties out to 200 yards, but at greater distances rounds lost most of their stopping power. Thus some gunsmiths began to experiment with rifling, a concept that dated to the early 1500s. The rifled barrel has longitudinal grooves cut into the inner surface of the bore. This was first done to facilitate the cleaning of the bore, which tended to become

fouled from gunpowder residue. It was discovered that if these grooves were given a slight twist, it would cause the ball to spin and make it more resistant to changes in direction due to wind and air density, thereby increasing range and accuracy. Thus was born the rifled bore. Such weapons require a bullet that fits the bore tightly, making it much slower to load than a smoothbore. In warfare during this era, it was more important to fire quickly than accurately; the volume of fire was key. Therefore, rifled muskets were initially used only by sharpshooters and other special troops, and the smoothbore musket remained standard for most armies. By the early 1830s, however, rifling had become universally accepted, and the smoothbore gun, except for the shotgun, was a thing of the past.

One of the breakthroughs that led to widespread adoption of the rifled musket was the invention of a new type of bullet by a French Army officer, Captain Claude E. Minié, in 1849. Minié discovered that elongating the round bullet would increase the spinning effect, thereby further improving range and accuracy. The Minié ball was a cylindro-conical bullet with a cavity at its base and a small wedge, or plug, set into the cavity. This bullet could be easily dropped down the barrel, but when the gun was fired the explosion of powder drove the plug up into the soft lead bullet and expanded it sufficiently to make it fit the bore tightly. An American, James H. Burton, improved the bullet when he discovered that if the cavity in the base of the ball were properly designed it would expand by itself, without the wedge. The United States promptly adopted the new bullet and began to manufacture weapons to take advantage of the new ammunition. The Minié ball ended the era of the smoothbore musket. The effectiveness of the rifled musket was first demonstrated during the Crimean War (1854–1856). During this conflict, Russian troops armed with smoothbore muskets proved no match for British soldiers using rifled Enfield muskets using Minié bullets. The rifled musket was the ultimate muzzleloader and held sway on the battlefield for the next decade.

The United States Army had adopted rifled muskets as the standard infantry weapon by the early 1850s. Thus, the rifled musket was the most common infantry arm on both sides throughout the entire Civil War. The tactics used during this conflict were based upon the old smoothbore musket and patterned after Napoleonic warfare, which relied on massed frontal assaults. However, the rifled musket and Minié ball provided a much more accurate, more powerful, and infinitely more deadly weapon that greatly increased the ability of infantry on both sides to produce casualties at a new rate.

Individual soldiers could now hit their opposing numbers with accurate and deadly fire out to more than 250 yards. Technology had far outstripped tactics; both North and South continued to use the tactics that had worked reasonably well against smoothbore weapons, but with the increased accuracy and lethality of the rifled musket and its prevalence on both sides, the situation had changed. Outdated tactics and massed frontal assaults in which soldiers advanced in neat ranks across open fields (the old linear tactics of continental Europe) in the face of these new and more lethal weapons resulted in the bloodiest war in U.S. history, in which more than 600,000 Americans on both sides died.

Despite the carnage wrought by the rifled musket on American battlefields, the increased demands of warfare for more rapid and accurate shooting were becoming too insistent to ignore, and the Civil War proved to be the last gasp of the muzzleloader.[11] The muzzleloader had a slow rate of fire and other disadvantages that motivated inventors and gunsmiths to try to improve on the concept. There were three areas in which they focused their efforts; none were entirely new.

Cartridges

One of these developments—the improvement of the cartridge—would provide a foundation for further advances in small-arms technology that would open several new doors. The first widely used cartridges were paper and included a package that contained the bullet and a charge of powder (like those used in the Revolutionary War). This was not a new idea; it actually dated to about 1500. The early cartridges contained only the powder and the bullet was added separately. Around 1700, someone decided that the bullet could be included in the cartridge, thereby greatly speeding up the loading process. This remained the standard for more than a century. Even though percussion-cap arms replaced flintlocks in the nineteenth century, the paper cartridge remained essentially unchanged.

Despite the speed and convenience that the paper cartridge offered, it also presented serious drawbacks. It was fragile, apt to break open and spill its contents with rough handling. It also presumed that the soldier had sufficient teeth to bite off the end of the cartridge prior to pouring it down the bore (note the source of the adage "bite the bullet"). Over time, various materials were used to replace the paper in the cartridge—cardboard, linen, intestinal

membranes from oxen, metal foils, rubber, and eventually full metal cases.

The final problem was that the paper cartridge lacked a primer. A spark had to be produced by flint striking steel or by a separate percussion cap affixed to the firing mechanism of the weapon. Therefore, some inventors turned their attention to the problem of adding a primer to the cartridge. One of the first men to succeed was Johannes Samuel Pauly, a Swiss gunsmith living in Paris. In 1812, Pauly invented an improvement that had revolutionary implications: a cartridge that included its own primer. This cartridge had a brass head with a small depression in the center that held a pellet of detonating compound. The weakness of Pauly's cartridge was that the primer was located outside the cartridge and could fall out and be lost, thereby causing a misfire.

Later cartridges consisted of just a bullet holding a combination primer-propellant charge in a hollow base. The Smith & Wesson Volcanic Rifle, first produced in 1854 and considered to be the immediate ancestor of the Henry and Winchester repeating rifles, used such cartridges, but the loads were too weak to be very successful. Still, the evolution of the combination of primer and propellant charge led the way to the efficient modern cartridge.

Breech-Loading

The development of the modern cartridge paved the way for the second important development: breech-loaded weapons. The idea of loading a weapon at the breech end, rather than packing ammunition down the muzzle, was also not new. Some of the early cannons had a separate breech chamber that could be loaded and then mated to the bore. However, the technology of the times did not allow for the gastight fit necessary for an effective weapon; without it, the force of the propellant charge was dissipated and the weapon suffered in muzzle velocity and range. It was found that the breech-loading approach would actually work better on smaller weapons, so the idea was applied to shoulder weapons and handguns. Many types of breech-loading techniques were tried in the late seventeenth and eighteenth centuries, but given the craft-based manufacturing capabilities of the day, the development of an effective breech-loader was greatly inhibited, and none designed during this period were suited to large-scale production.

Over time, technological advances and improved manufacturing techniques enabled inventors and gunsmiths to develop more effi-

cient breechloaders. Swiss gun maker Johannes Pauly, one of the pioneers in cartridge technology, developed a breech-loading sporting gun in 1812. This weapon featured a hinged barrel that permitted access to the breech, where one of his cartridges could be loaded and the barrel closed for firing. Pauly tried to interest Napoleon in his weapon for military uses, but the weapon was expensive and relatively delicate compared to the infantry weapons in use at the time.

Other gun makers modified and improved Pauly's design. A Frenchman named Casimir Lefaucheux used Pauly's idea to produce one of the first practical breech-loading weapons in 1835. Lefaucheux retained most of Pauly's gun but invented an entirely different cartridge that was built around a brass case that carried a percussion cap inside, together with the charge of powder and the shot or bullet secured into the cartridge. The pinfire cartridge was much easier to extract; thus the weapon became much more practical. Lefaucheux's breechloader became widely popular among sportsmen but was not widely used in the military.

Between 1827 and 1835, a Prussian named Johann Nikolaus von Dreyse developed the progenitor of breech-loading bolt-action rifles: the *Zundnadelgewehr*, or needle-fired gun. This weapon employed a cartridge similar to that used in the muzzleloaders of the day. However, it had two significant differences. The first was a long firing pin, or needle, that went through the cartridge and pierced the percussion cap at the base of the bullet. The other major development was the use of a sliding bolt to seal the breech once the weapon was loaded. The bolt was opened to the rear for loading, then slid forward and locked for firing. This created the seal in the breech necessary to harness the full force of the propellant charge. The Prussian Army adopted the needle gun in 1843, but few observers recognized the significance of the weapon until the Prussians used it to great effect in the wars against Denmark in 1864 and then against Austria in 1866. For example, in the Battle of Koniggratz, Prussian soldiers, lying prone, were able to fire six shots for every one fired by their Austrian opponents using muzzleloading rifles.

Other armies began to notice the needle gun and its ability to produce rapid and accurate fire. The French, always with an eye on the Prussians, took steps to develop their own breechloader. Borrowing the idea of the needle gun, Antoine Alphonse Chassepot invented a bolt-action rifle that was adopted by the French Army in 1866. Chassepot's rifle was a smaller caliber than the Prussian gun, which gave it longer range and greater accuracy. When the Franco-

Prussian War broke out in 1870, the Chassepot rifle more than held its own against the Prussian weapon. Observers from other armies were able to see the results achieved when two first-class armies armed with bolt-action breechloaders met on the battlefield. Close-order troop formations and cavalry charges were largely abandoned due to the effectiveness of the bolt-action breechloaders on both sides. The results of this war proved conclusively that the breech-loading rifle was a necessity for modern armies, and the nascent industry busied itself with testing competing designs.[12]

Paralleling the early advances in developing effective breech-loading techniques were new gains in the development of self-contained cartridges. In 1854, Englishman Charles Lancaster produced a shotgun using a drawn copper gastight case with a percussion cap in the base. This greatly simplified the operation of the cartridge, which could now be fired by a simple pin that struck the base of the cartridge. This was the first center-fire cartridge. From this idea evolved the rim-fire cartridge, whereby the priming mixture was placed in a rim at the base of the cartridge. Then the firing pin only had to strike the bottom of the cartridge anywhere on the base or rim in order to ignite the propellant charge in the cartridge.

The development of center-fire and rim-fire cartridges facilitated breech-loading technology during the 1860s and 1870s, when many different designs and approaches were developed. Once the hurdle of designing an effective breechloader was negotiated, the natural progression was to try to develop a weapon that could be fired several times in rapid succession. While this idea was applied to hand weapons and resulted in what we know as the modern handheld revolver, for the purposes of this discussion we focus on shoulder weapons.

Repeating Arms

One of the groundbreakers in producing the repeating rifle was Benjamin Tyler Henry, a gunsmith who worked for Oliver Winchester, a haberdasher who had bought out the bankrupt Volcanic Repeating Arms Company in 1857. The earlier Volcanic repeating rifle had employed lever action to cock the hammer, feed a cartridge, and close the breech. Henry took the earlier rifle and gave it a thorough overhaul. Using the earlier weapon design and a caliber .44 rim-fire cartridge, Henry fashioned a breech-loading rifle that employed a tubular magazine affixed to the bottom of the rifle barrel. Cartridges

were loaded into the magazine and forced backward toward the breech by a spring. A lever behind the trigger was pushed down, which pulled a toggle arm that drew the breech block backward, cocking the hammer. Raising the lever lifted a cartridge from the magazine and closed the breech block so that it pushed the cartridge into the chamber. This idea was patented in 1860 and sold by Winchester's New Haven Arms Company. This weapon would eventually evolve into what became the famous Winchester lever-action rifle.

Other improvements in breech-loading technology were made during the 1860s by gunsmiths like Christopher Spencer and Henry Peabody of Boston and the Swiss engineer Frederich von Martini. However, when the U.S. Civil War broke out, both armies were already armed with muzzle-loading rifles, and it would have been prohibitively expensive for either side to rearm with the new breech-loading repeating rifles, even if the technology had been fully perfected. Therefore, Henry, Spencer, Peabody, and Martini repeating rifles were used only sparingly during that war.

The introduction of metallic cartridges and the continuous advances in repeating rifles soon made it clear that the nature of land warfare had transformed. This was first seen in the Russo-Turkish War of 1877. During the siege of Plevna, Bulgaria, the defending Turks, armed with Winchester and Peabody-Martini rifles, cut down some 26,000 attacking Russians. Although the Russians eventually starved out the Turks after six months, the potential impact of the repeating rifle had been confirmed.

New Challenges

With breech-loading as well as repeating technologies perfected, the problem for large armies throughout the world was how to convert cheaply from the muzzle-loading weapons that were prevalent. The initial response was to convert existing muzzleloaders to breechloaders. Most countries adopted this solution; they took the existing weapons, cut away the chamber area, and dropped in a new chamber that was hinged to the existing barrel. An example of this approach was the U.S. Springfield Trapdoor conversion rifle that entered service in 1870 and was used until it was replaced by a bolt-action magazine rifle in 1892. This weapon employed a hinged-breech trapdoor mechanism, in which the top of the breech was flipped forward along the top of the barrel during loading.

Germany and France were ahead of the game, both having devel-

oped working bolt-action rifles. The only conversion that they had to make was to the use of metallic cartridges. Captain Basile Gras of the French Army produced his conversion of the Chassepot rifle to use a metallic center-fire cartridge; it was adopted by the French Army the following year.

Germany, having beaten the French in 1871, was in less hurry to change. Von Dreyse's son produced a conversion of his father's needle gun, but the German Army turned it down. However, the brother team of Peter Paul and Wilhelm Mauser produced a bolt-action single-shot weapon firing an 11mm bullet from a metallic cartridge case in 1871. This was the first in a long line of weapons that the brothers would develop for the German Army. In 1884, a new Mauser was introduced that used a tubular magazine under the barrel and a cartridge lifter operated by the movement of the bolt. This was a quantum leap, because the weapon could be loaded with eight rounds and fired as rapidly as the bolt could be operated. Adopting this weapon gave the German Army a great advantage.

In the early 1880s, a major development set the stage for the introduction of a workable rapid-fire machine gun: more powerful and cleaner-burning, nitrocellulose-based propellants came to replace black gunpowder. Gunpowder produced a large quantity of solid material upon combustion, quickly fouling barrels and resulting in the discharge of huge clouds of smoke. Nitrocellulose produced mostly gas and was therefore labeled as smokeless powder. This powder proved to be useful on the battlefield because weapons now gave off a smaller signature upon firing; more importantly, the cleaner-burning quality of the powder would assist in the development of firing mechanisms that would lead to a rapid-fire weapon.

Other advances that were made around the end of the nineteenth century included bottle-necked cartridges and metal-jacketed, or compound bullets. Using this technology, the French introduced the Lebel rifle in 1886. It used smokeless powder and fired a lead-core, cupro-nickel–jacketed compound bullet. With this weapon, the French had taken a lead in the race to develop the most effective battlefield rifle.

In Austria, Ferdinand Ritter von Mannlicher came up with the concept of packet-loading, or clip-loading. He put a box-shaped magazine beneath the bolt. After opening the bolt, the firer could drop a springed steel clip containing five cartridges into the magazine. The action of the bolt forced the bullet out of the clip and into the chamber. The opening of the bolt extracted the spent cartridge; the return stroke of the bolt then loaded the next cartridge. A spring

in the bottom of the clip forced the remaining cartridges upward. Clip-loading greatly speeded the loading process. Mannlicher's design was adopted by the Austro-Hungarian Army in 1885.

Other inventors such as the Mausers, Edouard Rubin, James Paris Lee, William Metford, Ole Krag, and Erik Jorgensen made additional improvements to the bolt-action concept. By the beginning of World War I in 1914, all the major powers had adopted smokeless powder, bolt-action, magazine-fed repeating rifles as their standard infantry weapon.

CONCLUSION

The advances in technology that saw the progression from the earliest cannons to the modern bolt-action rifle were necessary to the evolution of the machine gun. Put simply, the designs, techniques, and technology that began with the early cannons and resulted in the modern infantry rifle provided the foundation for the development of the automatic weapons to follow. Ideas such as the various locking systems, rifled barrels, percussion caps, breech-loading systems, metallic cartridges, smokeless powder, and self-loading mechanisms were steps along a process that provided the means and know-how to produce a multishot weapon that could spit out an almost continuous stream of bullets. As will be seen, the ultimate result would be a weapon that was so efficient it changed the face of warfare. Chapter 2 focuses on the earliest attempts to produce such a weapon.

NOTES

1. H. B. C. Pollard, *A History of Firearms* (New York: Lenox Hill, 1973), p. iii.

2. Some resources report that the Chinese also used black powder in crude cannons and, according to some sources, in bombs thrown by mechanical artillery.

3. Ian V. Hogg, *Guns and How They Work* (New York: Everest House, 1979), p. 8. A different legend with regard to Berthold says that he invented gunpowder itself.

4. W. Y. Carman, *A History of Firearms* (New York: St. Martin's, 1955), pp. 16-17.

5. Ibid., p. 19.

6. Small arms did not exist as a distinct class of gunpowder weapon until the middle of the fifteenth century; until then, hand cannons differed from their larger relatives only in size.

7. There is some disagreement among firearms historians about this story. Carman writes in *A History of Firearms* (pp. 100–101) that the derivation of snaphaunce is from the likeness of the flint-holder to a "pecking cock" and the chicken thieves were named after the weapon and not vice versa.

8. It is important, however, to note that the introduction of new ignition and locking systems did not immediately render older forms obsolete. Many variations existed side-by-side; wheel locks and matchlocks, for example, persisted into the eighteenth century, long after flintlocks had established their primacy in Europe and America.

9. Harold L. Peterson, *Pageant of the Gun* (Garden City, NY: Doubleday, 1966), p. 22.

10. Ibid.

11. Hogg, *Guns and How They Work*, p. 28.

12. Ibid., p. 32.

CHAPTER 2

Organ Batteries and Mechanical Machine Guns

Since the earliest days of firearms in the late middle ages, the idea of replacing masses of men with a single weapon that could fire a continuous stream of bullets had fascinated inventors and designers. However, early firearms technology precluded the practical realization of these ideas. There were no metals that could withstand the stresses of sustained fire. Additionally, manufacturing techniques were not sufficiently advanced to produce the machined parts necessary for such complex mechanisms.

ORGAN GUNS

The first attempts at sustained-fire weapons were volley guns, designed to fire a large number of shots at one time. Initial attempts used the *ribauldequin* concept, an idea that involved the use of multiple barrels. The first mention of such a weapon was in 1339, and they soon achieved widespread popularity. The first recorded appearance of the *ribauldequin* in battle was in 1382, when the men of Ghent, Belgium, marched on Bruges with several of these weapons. They were light, wheeled carts with a number of small-caliber cannon barrels fixed to the bed of the cart. A piece of match

connected all the touch holes on the cannon barrels, and by firing the match the barrels were fired in succession.

Most of the early attempts typically involved a cluster or row of barrels fired simultaneously. Because the parallel barrels of this type of weapon reminded some viewers of the pipes of an organ, they came to be known as organ batteries or death organs. In 1457, a Venetian general employed organ guns at the Battle of Piccardini as a mobile auxiliary to armored cavalry. There were numerous other documented uses of such weapons during this period, including one by Leonardo da Vinci.

Despite the potential of organ guns, there were serious disadvantages. The major drawback was the need to muzzle-load each individual barrel after the weapon was fired, leading to long periods of inaction. The inability to deliver sustained fire in sequence restricted it to a supporting or auxiliary role. Even though volley guns were not repeating arms, they demonstrated the utility of large volumes of fire and motivated inventors to develop weapons that could produce the required firepower over sustained periods.

The development of the multi-fire weapon was slow. In England, during the reign of Charles I, William Drummond was granted a patent in 1625 for his Thunder Carriage, an organ gun operated by two men (and claimed to be effective against 100 enemy). Some forty years later, in 1663, a British inventor named Palmer presented a paper to the Royal Society in London in which he explored the possibility of using the force of recoil and the gases produced by the exploding charge in a firearm to load, discharge, and reload a volley-fire weapon. Palmer was a visionary some 200 years ahead of his time. Even though advances had been made in weapons technology, serious limitations in manufacturing techniques and metals precluded the practical application of Palmer's ideas. There were other limitations in the development of a multiple-fire weapon. As long as the only ammunition was a lead ball and the only means of ignition a heap of gunpowder and a sharpened flint, the results were never likely to produce a practical weapon. Additionally, given the state of weapons technology at the time, the chambers of any gun could not be properly sealed; thus the escaping gases could not be captured to harness the energy necessary to operate the gun. Moreover, until the development of the metal cartridge, there would be serious problems with clearing the weapon after firing. Palmer's theory was sound, but there is no evidence that any prototype based on his ideas was ever built.

It was not until 1718 that an Englishman named James Puckle

invented what proved to be one of the key steps in the evolution of mechanical machine guns. That year Puckle, a London solicitor, patented what he called the Defence Gun. There is some argument among historians about whether this was the first patent of a manually operated revolving-type machine gun, but the importance of Puckle's gun is that it certainly represents the most refined design to be found till that time. The Defence Gun was mounted on a tripod and was surprisingly modern in appearance. Puckle's gun was essentially a large-caliber flintlock revolver; its main feature was a large revolving cylinder that held a varying number of chambers. The loaded cylinder is lined up with the barrel and locked in place, thrusting the chamber mouth into the rear end of the barrel to seal the joint against gas leaks. A manually operated crank movement brings the chambers one by one to the breech of the gun's single barrel. Then a lever is tripped to release the cock of a flintlock mechanism, which ignites the charge in the chamber. After the first shot, the cylinder is unclamped, moved around to line up the next loaded chamber with the barrel, reclamped, and fired. Once the cylinder is empty, the operator can loosen the crank, allowing it to be taken off and a fresh one loaded. The top part of the weapon, turned laterally and freely, provides a large arc of fire. The illustration of Puckle's gun from the patent indicates that the designer was far ahead of his time. As rudimentary and clumsy as it seemed, Puckle's gun is a direct ancestor of the modern machine gun.

Puckle demonstrated the weapon to the English Board of Ordnance in 1717, but they were not impressed. He demonstrated it several more times; at a public trial held in 1722, the gun was able to fire 63 shots in seven minutes in the midst of a driving rain storm, an amazing feat for the period. In spite of offering the gun for sale in a variety of sizes, and even offering the rather bizarre provision for firing square bullets at Turks (round projectiles were to be reserved for Christian targets), Puckle never prospered with it. There is some evidence that the Duke of Mantagu purchased two of the guns, using them to arm his expedition to colonize the West Indies, but there is no record that they were actually used.

Preventing the ultimate acceptance and success of Puckle's gun and similar weapons were the same problems that plagued earlier efforts: the clumsy and undependable flintlock ignition, and the mechanics of flint, steel, powder, and shot. All these impeded inventors and limited the effectiveness of weapons during this era. One of the few remaining specimens of Puckle's gun resides in the Tower of London armory.

BATTERY GUNS

In the ensuing years, inventors continued to toy with the idea of a multiple-fire weapon. During this period, the *ribauldequin* concept was revived periodically. There were attempts to perfect what became known as the battery gun, because they consisted of a battery of gun barrels. However, by the late eighteenth century, most of these efforts had proved less than effective because the battery gun was also constrained by the limitations of powder, ball, flint, and steel.

But with the invention of the percussion system by Reverend Forsyth in 1807, one of the principle problems with rapid-fire weapons was solved; the way was paved for advances in weapons technology. As time passed and more technological advances were made, inventors tried other approaches in the development of rapid-fire weapons. One of these was the swivel gun invented by Joseph G. Chambers of Pennsylvania. He took out a patent in 1813 for a system of repeating gunnery. His gun had seven barrels, each containing 32 balls that used the roman-candle approach. A burning fuse set off the charges one after another, delivering an impressive number of shots in a short time. However, the firing was impossible to stop once the fuse was ignited, and the gun kept firing until the last charge explodes and the bore was empty. The U.S. government purchased Chambers's guns, and several were used against British forces on the Great Lakes in 1814 during the War of 1812.

There were some inventors who tried to circumvent the powder and ball restriction by finding other means of propelling the bullet. Among the more practical ideas was the Steam Gun of Jacob Perkins, patented in 1824. Perkins was an English engineer who had invented an improved steam generator, which could be made portable and produced a useful steam pressure without danger of explosions. He applied this generator to the idea of a steam-driven gun. He demonstrated the completed design to the Royal Board of Ordnance in 1826. His gun was essentially a tube with a valve at one end into which steam was piped. Above this was a vertical magazine loaded with 1-ounce lead balls. Having achieved steam pressure, the operator depressed and released a lever that fed the balls one by one into the breech, where a burst of steam at about 200 pounds per square inch blew the ball down the barrel and out the muzzle with sufficient force to penetrate 12-inch oak planks or quarter-inch iron plate at a distance of 35 yards. The operator could

get 60 shots per minute out of the gun, and as long as steam pressure was maintained and the weapon was fed, it potentially could fire indefinitely because there was nothing to wear out.

Despite the potential of his weapon, Perkins was not able to convince the Board of Ordnance to buy into it, so he traveled to France, where he sold one gun to the French Army. He died sometime in the 1830s; his work was carried on by his son, who improved the design, increasing the steam pressure and providing much better range and penetration. However, the son, like his father, was unable to generate official interest in his idea, and the weapon entered the dustbin of history.

Though progress in developing a multifire weapon was slow during the early 1800s, advances like the percussion cap and the metallic cartridge paved the way for the invention of numerous machine guns in the United States and Europe. During the early Industrial Revolution, mechanical marvels were the order of the day, from steam locomotives to printing presses, yet the military forces of the world were still using weapons that in their essentials had changed very little from the early eighteenth century. However, the demands of nineteenth-century warfare, and the Crimean War and U.S. Civil War in particular, changed everything. All over Europe and the United States, inventors began to take a fresh look at weaponry, and this led to the development of new rapid-fire weapons that would eventually transform warfare and tactics.

THE INDUSTRIAL REVOLUTION AND MACHINE-GUN PROTOTYPES

The fundamental changes, including manufacturing and financial practices, that came about during the Industrial Revolution greatly speeded machine-gun development. The first patent using the term "machine gun" was issued in the United States in 1829 to Samuel L. Farries of Middletown, Ohio. This grant seems to imply that the term was to be assigned to any mechanically operated weapon of rifle caliber and above, regardless of whether the energy necessary for sustained fire was derived mechanically or from some other source of power. As it turned out, however, the weapons of the nineteenth century would all be manually operated. Because it was always necessary for a gunner to aim the weapon, there seemed to be no reason

why he should not also furnish the power to feed and fire the gun. The challenge for inventors was how to devise a mechanism to make that possible.

In the 1850s, Sir James S. Lillie of London attempted to combine both the multibarrel and the revolving chamber systems. He arranged 12 barrels in two rows. Each had a cylinder, as with a revolver, behind it. A hand crank tripped the hammers of each unit, either simultaneously to produce a 12-barrel barrage of fire, or consecutively to produce a continuous ripple of fire from each barrel in turn. The problem with Lillie's gun was that it took a long time to reload. Thus it had little appeal for the military and the only specimen ever made now resides in the Royal Artillery Museum at Woolwich in London.

In the United States, other inventors continued to work on perfecting a multifire weapon. Improvements to percussion caps and subsequent developments in the evolution of the cartridge paved the way for new advances. Ezra Ripley, of Troy, New York, took advantage of the paper cartridge developed by Samuel Colt and the Ely brothers of England to patent a hand-cranked machine gun. Ripley achieved sustained volley fire by a compact firing mechanism that allows the gunner to fire one shot, or the whole volley, with a quick turn of the handle. The weapon consisted of a series of barrels grouped around a central axis. The breech lock, made in the shape of a revolving cylinder, was loaded with the conventional paper cartridges of the time. The breech was then locked into place by securing the operating handle. This aligned the chambers containing the cartridges with the rear of the barrels. With a turn of the handle, the firing pin was cocked and released, firing the weapon. Once the weapon was fired, the gunner then pulled the firing assembly rearward, removed the empty cartridges and reloaded the empty chambers. As preloaded cylinders were made available, a single operator was able to produce more sustained fire than a company of men using the standard muzzle-loading musket of the day. However, U.S. military observers evaluating Ripley's prototype expressed serious doubts about overheating of the barrels and ammunition resupply. In the end, the U.S. Army, which ordered little more than conventional arms like muskets and cannons during this period, was not interested in Ripley's invention. Nevertheless, it was a promising weapon that had many features that greatly influenced machine-gun design for years.

Some of the difficulties incurred by arms inventors in marketing their ideas were reduced with the onset of the U.S. Civil War; the

needs of industrialized warfare spurred weapons inventors and added new impetus to the development of volley-fire weapons and ultimately the mechanical machine gun. One of the most effective of the volley-fire weapons during the Civil War was the Billinghurst-Requa battery gun, built in late 1861 by the Billinghurst Company of Rochester, New York. Designed by Joseph Requa of Rochester, this weapon was yet another revival of the fourteenth-century *ribauldequin* brought up to date. The weapon consisted of 25 rifle barrels mounted side-by-side on a light wheeled carriage. The barrels were each loaded with a brass cartridge containing gunpowder and a bullet and having a hole in the base. A steel block closed all 25 breeches and was perforated to allow the flash from a single cap, which was placed on a nipple on the iron frame and fired by a hammer, to pass through and ignite the 25 cartridges in a ragged volley, after which the 25 barrels had to be emptied of the spent cartridges by hand and reloaded before the gun could fire again. It produced a blast of fire that could cut down a charging enemy.

The Billinghurst-Requa battery gun, although primitive by later standards, had a few unusual features that merit mention. Requa had solved the inevitable long pause for reloading by making his weapon a breechloader. The clip-loading feature and quick means of locking and unlocking the bolt allowed for a decent rate of fire. The gun was demonstrated in New York shortly before the Civil War broke out, and several were purchased by the Union and the Confederacy. They were used to protect vulnerable points, notably bridges and similar places where an enemy attack could be channeled into a narrow space and a sudden blast of fire delivered. As a result, these weapons became known as bridge guns. Despite its potential, the battery gun had its limitations and did not represent a great leap forward in rapid-fire technology. Additionally, there were questions about how such guns would best be used on the battlefield. The gun was demonstrated for the Ordnance Select Committee in London in 1863, and the observers attending were less than impressed. The committee thought that the gun could not be a substitute for any existing field guns and questioned its utility for the infantry. Ian V. Hogg, a modern expert on weapons and their development, maintains that "this short report pinpoints the greatest problem facing the early development of machine guns: how were they to be used?"[1] Most military observers saw them as some sort of artillery weapon and contended that they should be handled in the field in the same manner, that is, setting up some distance from the enemy to take him under fire. According to Hogg, "It was this ques-

tion of method of employment that was to be the greatest brake on the early development" of the machine gun.[2] Very few observers realized the potential of these weapons and how they would change the nature of armed combat.

A different approach during the Civil War was taken by Wilson Ager (sometimes spelled Agar). His invention was called the Coffee Mill because the ammunition was fed into the top through a funnel-shaped hopper resembling an old-time coffee grinder. Ager's gun, also known as the Union Repeating Gun, was unique in that it had only one barrel. A number of steel tubes, into which powder and a bullet were loaded, provided the firepower; on the end of each tube was a nipple on to which a percussion cap was placed. The tubes were then dropped into the hopper and gravity-fed one at a time by rotating the crank. This pushed the first tube from the hopper into the chamber of the barrel, locked the breech block behind it, and then dropped a hammer onto the cap and fired the caliber .58 Minié-type bullet out of the barrel. Continuous rotation of the crank withdrew the empty tube and ejected it, then fed the next tube in, and so on. The gunner's mate had the job of picking up the empty tubes and reloading them as fast as he could, dropping them back into the hopper.

The gun, which Ager described as "An Army in Six Feet Square," worked reasonably well, particularly for its day. The inventor claimed that the weapon could fire 100 shots per minute. This was probably an exaggeration, and that claim was no doubt received with great skepticism. This response was probably well-founded, because 100 shots per minute meant exploding a pound or so of gunpowder every minute. In truth, the gun probably could not have withstood the heat generated. (The problem of heat buildup in the barrel would be one of the recurring difficulties that had to be overcome in the development of an effective machine gun.) Nevertheless, Ager conducted a demonstration firing for President Abraham Lincoln, who was so impressed with the weapon that he authorized the purchase of 10 units on the spot. Eventually Ager sold more than fifty Coffee Mills to the Union Army. Generally, they proved to be unreliable in combat and were never employed en masse. According to one reference, they were incorporated into the defenses of Washington and were only occasionally fired at Confederate positions along the Potomac River.[3] They were usually relegated to bridge duty, like the Requa. In the end, the Coffee Mill was not adopted in great numbers because contemporary authorities, failing to see its great

potential, condemned it as requiring too much ammunition ever to be practical.

Captain D. R. Williams of the Confederate Army invented a mechanical gun that was also used during the Civil War. This weapon, a 1-pounder with a bore of 1.57 inches and a 4-foot barrel, was mounted on a mountain howitzer–style horse-drawn limber. This weapon was really a cross between a machine gun and a light repeating cannon. The firing mechanism was operated by a hand crank located on the right side. The weapon used a self-consuming paper cartridge and was capable of 65 shots per minute. It was fairly reliable but had a tendency to overheat when fired for extended periods. The Williams gun was first employed on 3 May 1862 at the Battle of Seven Pines in Virginia. Some historians maintain that this was the first machine gun to be used in battle, but weapons historian Ian V. Hogg disputes this claim, arguing that the Williams gun cannot be classed as a true machine gun, since it was necessary to put each round into the feedway by hand. The Williams, according to Hogg, "was simply a quick-firing breech-loader, operated by a hand crank."[4] Nevertheless, these weapons were used by the Confederacy for the rest of the Civil War with some success.

Another American, General O. Vandenberg, also invented a new weapon, a volley gun designed for "projecting a group or cluster of shot."[5] This weapon employed 85 to 451 barrels, depending on the size of the projectile for which it was designed. Each barrel was loaded with a bullet and then the breech was closed. When the operator manipulated a lever, measured charges of powder were dropped simultaneously into each chamber. The method of ignition was percussion: a centrally located charge ignited the whole volley simultaneously. With so many barrels, the weapon was extremely heavy. Vandenberg built the first guns in England and tried to market them there. The British showed some interest in it for use aboard ships but believed that it had little potential as a land weapon due to its weight. Vandenberg, at the outbreak of the Civil War, made many attempts to sell the weapon to the U.S. government. He even gave three weapons to the secretary of war for testing. After very comprehensive field trials, it was found that it took nine hours for one man to clean the bore and chambers of the weapon adequately after firing. This maintenance problem and the weight issue doomed the weapon, and it was deemed unacceptable for Union service. Several of these guns were used by Confederate forces, but they were stamped with the name of the British manu-

facturing company, Robinson and Cottam. There is a record of one being used in the defense of Petersburg, Virginia.

The Gatling Gun

The most famous and successful of the mechanical machine guns was invented by Richard Jordan Gatling. Rather than practice medicine after completing medical school, Gatling spent his life inventing things, including a steam plow, a mechanical rice planter, and a hemp breaker. However, it was in the area of repeating arms that Gatling made his name. In 1861, taking advantage of the progress that had been made in machine tooling, he combined the best principles of the Ager and Ripley guns (although he denied that he had been influenced by either weapon), overcoming their more objectionable features. Because of his successful designs, Gatling has generally been credited with being the progenitor of the modern mechanical machine gun.

Gatling was fully aware of the problems with heat buildup from multiple explosions in a rapidly firing weapon. To overcome this, he designed the weapon with six barrels that would be fired in turn. This ensured that with a total potential fire rate of 600 rounds per minute, each barrel would only fire 100, allowing them to cool down.

The first Gatling gun, patented in November 1862, consisted of six barrels mounted around a central axis in a revolving frame with a hopper-shaped steel container similar to the Ager. The barrels were cranked by hand. The weapon used small steel cylinders that contained a percussion cap on the end, the bullet, and paper cartridges for the charge. It was loaded by placing the steel cylinders into the hopper above the gun, which fed the rounds into the breech by gravity. As the handle was turned, the six barrels and the breech mechanism revolve, each barrel having a bolt and a firing pin controlled by a shaped groove in the casing around the breech. As the breech revolved, the bolts were opened and closed and the firing pin released from the action of studs running in the groove. When any barrel was at the topmost point of revolution, the breech bolt was fully open and as it passed beneath the hopper a loaded cylinder was dropped into the feeder. As the barrel continued to revolve, the bolt was closed, leaving the firing pin cocked; as the barrel revolved to the bottommost point, the firing pin was released and the barrel fired. Further revolution caused the bolt to open and the empty case to be

ejected, just in time for the barrel to reach the top again with the bolt open, ready to collect its next cartridge and casing.

Gatling made arrangements for six weapons to be manufactured for an official test by the Union Army. Unfortunately, the factory in which the guns were being made was destroyed by fire, and the guns and all his drawings were lost. The inventor was not deterred, however, and he was able to raise enough money to manufacture 12 new guns. This time he did away with the metal cylinders, using rim-fire cartridges instead. This made the newer weapon easier to load and more reliable. Gatling boasted that the gun could be fired at the rate of 200 shots per minute.

Despite Gatling's claims, which were to be borne out by subsequent events, the Union Army failed to adopt the gun for two reasons. First, the army's chief of ordnance, Colonel John W. Ripley (later brigadier general), strongly resisted any move away from standard-issue weapons. The other reason was suspicion that Gatling's sympathies lay with the South. Although he had located his factory in Cincinnati, Ohio, Gatling had been born in North Carolina, which had joined the Confederacy. Therefore, to many among the Union leadership, his politics and sympathies were suspect. Gatling even appealed directly to President Lincoln, pointing out that his deadly invention was "providential, to be used as a means in crushing the rebellion."[6] Despite Gatling's offer to help the North win the war, many in the Union high command felt there was something odd about a Southerner offering a new gun to the Union and thus refused to even consider Gatling's invention. The only use of the Gatling gun during the Civil War occurred when General Benjamin F. Butler of Massachusetts personally purchased 12 guns for $1,000 each and later put them to good use against Confederate troops besieged at Petersburg, Virginia.

In 1864, Gatling completely redesigned the gun so that each barrel was formed with its own chamber, thus doing away with the separate cylinder and its attendant gas-leak problem. The gun now fed center-fire cartridges from a magazine on top. The cartridges were gradually fed into the chamber by cams as the barrels revolved, then fired at the bottom position, and were extracted and ejected during the upward movement. As the barrel reached the top it was empty and ready to take in the next round. The great advantage of this system was that it divided the mechanical work among six barrels so that all the machinery operated at a sensible speed. By this time, Gatling had refined the gun's design considerably, increasing the rate of fire to 300 rounds per minute and improving reliability.

Gatling intensified efforts to sell the gun to the U.S. government. He published a publicity broadsheet in 1865 that informed the world that his gun bore "the same relationship to other firearms that McCormack's Reaper does to the sickle, or the sewing machine to the common needle. It will no doubt be the means of producing a great revolution in the art of warfare from the fact that a few men can perform the work of a regiment."[7] At Gatling's urging, the U.S. Army finally agreed later that year to conduct a test. Pleased with the results, the Army formally adopted the Gatling gun in 1866, ordering 50 of 1-inch caliber (with six barrels) and 50 of 0.50-inch caliber (with 10 barrels). Gatling entered a contract with Colt's Patent Fire Arms Company of Hartford, Connecticut, to manufacture the guns for delivery in 1867. Gatling was so pleased with this arrangement that for as long as the U.S. government used the Gatling gun, it was manufactured by Colt.

Even though the U.S. Army had adopted the Gatling gun, there were two schools of thought among military men, both in the United States and elsewhere, about the best way to use it. One believed they should be used as artillery fire support; the other advocated its use for defending bridges and for street defense. Neither side recognized its true potential was as an infantry support weapon. This would be a recurring theme within the world's armies regarding the Gatling gun and subsequent machine guns, as doctrine and tactics failed to keep pace with technological advances.

With the Civil War over and the arms embargo enacted during the war lifted, Gatling and the Colt's Patent Fire Arms Company began marketing the weapon overseas, aggressively entering arms competitions throughout Europe. In each case, when a properly designed cartridge was used, the Gatling gun out-shot every competing design. In Great Britain, some military leaders had recommended the adoption of the machine gun, but cost considerations led Parliament to refuse to appropriate funding to develop such weapons. Nevertheless, the British Army tested Gatling's weapon at Woolwich in 1870 in competition with the Montigny Mitrailleuse, a 12-pounder breechloader firing shrapnel, a 9-pounder muzzleloader firing shrapnel, six soldiers firing Martini-Henry rifles, and six soldiers firing Snider rifles. The Gatling fired 492 pounds of ammunition and obtained 2,803 hits on various targets; the Montigny 472 pounds for 708 hits; the 12-pounder 1,232 for 2,286 hits; and the 9-pounder 1,013 pounds for 2,207 hits. The British were impressed with the Gatling's accuracy, its economy, and the fact that in timed fire it got off 1,925 rounds in 2.5 minutes. The test went so well

that the British adopted the Gatling in caliber .42 for the Army and caliber .65 for the Royal Navy.

Great Britain became one of the first countries not only to recognize the utility of the Gatling gun but also to put it into action. After some initial difficulties with the new weapon during the Ashanti campaign of 1873 in the territory that is now Ghana, West Africa, the British Army wholeheartedly endorsed it. Events elsewhere in Africa contributed toward the acceptance of the Gatling gun. In South Africa on 22–23 January 1879, the British had suffered a humiliating defeat at the hands of the Zulus under Cetshwayo at Isandlwana. In retribution for this defeat, a force of 4,000 infantrymen and 1,000 cavalry under the command of Lord Chelmsford set out to punish the Zulus. On July 4, the British, armed with two Gatling guns, engaged the Zulu warriors at Ulundi. The Gatlings wrought havoc among the Zulus, who had never gone up against such devastating fire. When the battle was over, more than 1,500 Zulus lay dead, most due to fire from the Gatlings. From then on the Gatling gun became a mainstay of British expeditionary forces in places like Egypt and the Sudan. Modern-day historian Robert L. O'Connell maintains that the Gatling and subsequently the Maxim machine gun were so popular with British colonial forces because "from an imperialist standpoint, the machine gun was nearly the perfect laborsaving device, enabling tiny forces of whites to mow down multitudes of brave but thoroughly outgunned native warriors."[8]

Over the next few years, most major armies in Europe, as well as those in Egypt, China, and much of South America, purchased Gatling's weapon. The Russian government, preparing for war with Turkey, ordered 400 Gatlings. A Russian general was sent to the United States to oversee their manufacture and inspect the units before acceptance and shipping. With considerable cunning, he replaced the original Gatling nameplates with his own before the guns were shipped to Russia. Not surprisingly, some Russians claimed that Gatling had stolen important elements of the Gorloff model, which was called the Russian Mitrailleuse.

Despite Russian claims of originality, the Gatling was popular and saw use in many theaters. The inventor continued to work for 30 years on improvements and conducted many exhibitions throughout Europe and South America. Various models of varying calibers were introduced. By 1876, a five-barreled caliber .45 model was firing 700 rounds per minute and even up to 1,000 rounds in a short burst. By the mid-1880s, the armed forces of almost every nation in the world included Gatling guns among their inventories.

The Gatling was an effective design and remained in use until technology evolved such that a single barrel could be manufactured to withstand the heat and wear of multiple firings. After that advance, the Gatling disappeared. Before then, however, the Gatling saw long war service in countries, primarily as a instrument of colonialism, whereby small numbers of European soldiers could defeat large masses of native troops in Africa, Asia, and elsewhere.

Despite the increased firepower of the Gatling, it had some limitations technically and tactically. The multiple barrels prevented excess heat buildup, but they were also a liability due to their weight. The weapon was best used in defensive situations because it was too heavy and unwieldy to use on the attack. For that reason, Gatlings were usually relegated to the artillery to be used in batteries, rather than distributed to infantry and cavalry units. There were a few instances where this was not the case. The Americans first used the Gatling against a foreign enemy during the Spanish-American War in 1898. Under the leadership of Captain John H. "Gatling Gun" Parker, a Gatling unit was organized and employed against the Spaniards at Santiago, Cuba. Parker took it upon himself to push the guns, mounted on carriages, forward on the flanks of the attacking force, keeping up with the advancing infantry and effectively clearing a path for them. This was the first use of the machine gun for mobile fire support in offensive combat. Parker quickly became one of the pioneers in the development of a tactical doctrine built around the use of the machine gun in support of the infantry.

The Gatling gun and its inventor were way ahead of their times. It was the only weapon in history to progress from black powder to smokeless powder, from hand power to fully automatic, and eventually to an electric-drive system that allowed 3,000 rounds per minute. All this was accomplished without any change to its basic operating principle before being abandoned as obsolete in 1911. It was also a design that would have applications in the modern era.

Other Prototypes

Undeterred (or rather spurred) by the Gatling's success, other inventors continued to develop weapons capable of sustained fire. Two approaches came to the fore. The first, thoroughly American and represented best by Gatling himself, focused on developing weapons that employed one or more barrels that did not fire simultaneously, achieving a high rate of fire by firing barrels successively

in a continuous stream of bullets. The other approach, popular in Europe, attempted to perfect the earlier volley system, whereby barrels were grouped in a plane, parallel or in stacks, and fired simultaneously and reloaded rapidly.

One of the most effective European-developed volley-fire weapons was invented in the 1850s by a Belgian Army captain named Fafschamps, some 10 years before Gatling introduced his design. Fafschamps's weapon was similar to earlier battery guns and was actually an update of the organ gun, but it was much more efficient. Fafschamps passed along his rough prototype and drawings to a Belgian engineer named Joseph Montigny, who used them to develop a weapon that has been known ever since as the Fafschamps-Montigny Mitrailleuse (literally, "grape shooter" or "grapeshot shooter"). By choosing this name, Montigny hoped to imply that this was a system for controlling the dispersion of grapeshot on the battlefield. It consisted of 37 rifle barrels, later reduced to 25, mounted inside a tubular casing that resembled a cannon mounted on a field-gun carriage. The major difference between this gun and the various models of U.S. mechanical machine guns is in the methods for charging and reloading. Rather than feeding single rounds into a rotating breech mechanism from a hopper or magazine, this weapon used a metal magazine plate. The breech block was moved in one piece to the rear by means of a long lever. The breech block contained 37 firing pins, which could be slid back, exposing the chambers of the rifle barrels. The metal magazine plate holding 37 cartridges was then dropped into a slot in the face of the block, the latter being pushed forward and the cartridges entering the barrel's chambers. Revolving a crank at the rear of the gun caused the 37 firing pins to fall simultaneously, firing all rounds in a single volley. Later versions of the weapon incorporated a cam mechanism that permited the gun to be fired more selectively, the rate of fire depending upon how fast one turned the crank. In either case, after firing, the block was opened, the plate full of empty cases removed, a fresh plate dropped in, the block closed, and the weapon is ready to fire again. A well-drilled crew with a supply of ready-loaded plates could keep up a rate of 150–250 shots per minute (and could even exceed 400 rounds per minute), firing the barrels all at once and 10–12 volleys per minute firing the barrels sequentially. The major drawback was weight: more than 2,000 pounds without ammunition.

Montigny constructed and sold some of his guns to the Belgians, who used them to defend fortifications. In 1867, Montigny was able to interest Emperor Napoleon III of France in his new weapon and

convinced him that it was the answer to gaining tactical advantage on the battlefield. In 1869, under conditions of great secrecy, manufacture of the guns began at the arsenal at Meudon under the direction of Montigny and Commandant Verchère de Reffye, the officer in charge at Meudon. Eventually 156 Mitrailleuses (of the 25-barrel variety in 13mm) were made for the French Army. Only the officers and men who would be charged with operating the weapons were ever allowed to see or to handle them. The guns were moved from the arsenal to storage under tarpaulins and accompanied by armed guards. The mystery surrounding the weapons led to fantastic stories in the French press about the new weapon and what it could do; reports appeared regularly, intimating that the weapon was capable of doing just about anything desired by the military and that it would help defeat the Prussians with ease.

Much of this publicity was intended to intimidate the Prussians, who had won a surprising victory over the Austrians in 1866 and were a major threat to France. Part of the Prussian success had been due to the introduction of the new Dreyse bolt-action needle gun, which made muzzleloaders obsolete and led to a new arms race in Europe. The French attempted to arm their forces with the Chassepot rifle as one answer to the Prussian advances in weaponry, but they could not restock their army quickly enough to prepare for the mounting trouble. The Mitrailleuse provided a possible solution to Prussian arms supremacy, which may have fostered in the French high command an "unwarranted sense of superiority."[9] The Prussians would soon prove that this new weapon was not as decisive as the French generals believed.

Armed with the Mitrailleuse and the Chassepot, the French went to war with Prussia in 1870 with high hopes, but the Mitrailleuse proved a great disappointment. So heavy was the veil of secrecy surrounding the new weapon that training and critical discussion as to how it might be used were virtually impossible.[10] The weapon worked well enough, and the Prussians were respectful of its power, but the tactical handling of the weapon was entirely off-base. The French treated them as a form of artillery, deploying a line of guns in the open to provide covering fire for the infantry. Since the maximum range of the Mitrailleuse was about 1,800 yards, and the maximum range of the Prussian artillery was about 2,500 yards, the result was predictable. As soon as the French unlimbered their weapons, the Prussians countered with their own artillery beyond the range of the Mitrailleuse and shot them to pieces. A good example of this can be seen in action at Wissembourg in August 1870

when the French brought up a battery of Mitrailleuses and positioned them on an unprotected hill. It was immediately spotted by Prussian artillery, which targeted the hill. The Prussian shells blew up one of the French ammunition wagons and mortally wounded the commanding general, after which the battery was withdrawn.

Later that month, at the Battle of Gravelotte, the French commander placed his Mitrailleuse in the infantry firing line, protected by a cluster of trees. Under these conditions, the French guns were much more effective, and the Prussians suffered heavy losses. The Mitrailleuse were also put to good use at Montigny and the Battle of Mars-le-Tour, but in each case the French failed to analyze the results of the battles and profit by their lessons with regard to the effectiveness of the new weapons. It all became moot when a sequence of Prussian victories culminated in the defeat of the French Army at Sedan on September 1, ending the war after only five weeks.

The French failure to take advantage of the potential of the Mitrailleuse was one of the factors that led to this defeat. During the short war, the French continued to use the Mitrailleuse as artillery, locating it alongside field pieces. The insistence on using the Mitrailleuse in this way nearly killed the very idea of the machine gun as an effective weapon; the failure of the gun in combat convinced the French that such weapons lacked utility on the battlefield. However, the French had failed themselves by not correlating the design to practical tactics; their tactical misuse doomed their new weapon. Despite the advantages that the Mitrailleuse provided on the battlefield, its dismal record in the hands of the French resulted in France abandoning it. This earned the Mitrailleuse the dubious honor of being the shortest-lived rapid-fire weapon ever to be adopted by a major power. About all it contributed to the development of quick-firing weapons was the name Mitrailleuse, used by the French for many years thereafter in referring to machine guns.

British representatives had observed the Franco-Prussian War but had been unimpressed by the Mitrailleuse. The British director of artillery wrote in December 1871 that the "[Mitrailleuses], in my opinion, are comparatively feeble weapons, and their spheres of usefulness in war is very limited."[11] According to military historian Trevor Dupuy, the failure of the Mitrailleuse would be misinterpreted by many observers, and that misinterpretation would delay the adoption of the machine gun in the armies of France and Britain, "a cruel handicap at the opening of World War I."[12]

The Germans, on the receiving end of the Mitrailleuses, dev-

eloped their own early machine gun. The Feld gun was a Mitrailleuse-type weapon that had 24 barrels mounted in parallel rows and was worked by a crank handle, firing about 300 shots per minute. However, it was not a very good weapon and tended to jam and overheat and was generally not reliable mechanically. The Germans were not happy with the Feld gun's performance in combat, which contributed to a general disregard for machine guns, something that persisted in the German Army for years after 1870. Yet they overcame this initial assessment and came to recognize the machine gun's potential much faster than did their future opponents. One reason the Germans would eventually adopt machine guns was to rectify deficiencies in the musketry capabilities of their reserve formations, but the Germans would also equip regulars with these weapons once perfected.

While military leaders on the continent wrestled with the utility of machine guns on the battlefield, U.S. gun makers continued to study sustained fire. Lacking the European prejudice fostered by the failure of the Mitrailleuse and the Feld gun in combat, they came up with several different designs for hand-operated machine guns. W. B. Farwell of New York City developed a machine gun of novel design in 1870. This weapon was similar in appearance to the many multibarreled guns that were introduced shortly after the Civil War. However, since there were already so many better weapons like the Gatling gun in existence, no one was interested in financing the production of Farwell's gun, and only one prototype was made.

In 1871, Benjamin B. Hotchkiss, born in Watertown, Connecticut, unveiled a rapid-fire weapon that he had been working on for four years. Hotchkiss served his apprenticeship and became a master mechanic at Colt's Hartford plant. He is credited with several inventions, including a rifled field piece that was purchased by the Mexican government in 1860, as well as a new kind of percussion fuse for projectiles. Like other U.S. inventors of the time, Hotchkiss felt that his firearms knowledge was not appreciated in the United States. Therefore, he went to France in 1867. After designing an improved metallic cartridge for the Chassepot rifle, he began to work on a machine gun. The result was really a revolving cannon rather than a true machine gun, but it was a novel and useful weapon that added much to the evolution of the mechanical machine gun. Hotchkiss's prototype was received so well that he organized the Hotchkiss & Company with offices in Paris and a manufacturing plant in nearby St. Denis.

The Hotchkiss gun used a system of five revolving barrels operated by a hand crank. The big difference between the Gatling and the Hotchkiss is that whereas the Gatling had a bolt and breech mechanism for each barrel, the Hotchkiss had only one bolt, which locked and unlocked into each barrel in turn as it rotateed past the bolt station. This results in a slower rate of fire, but this was deemed acceptable since the Hotchkiss fired a 37mm round, a much larger shell than earlier machine guns. Although planned as an army gun, its only land use was for arming continental forts. Ultimately, the Hotchkiss was adopted as a navy gun used as a ship-borne defensive weapon against high-speed enemy torpedo boats. The revolving cannon was eventually used at one time or another by every navy in the world, including those of Germany, England, France, Holland, Italy, Denmark, Austria, Russia, Turkey, and the United States. The Hotchkiss gun went a long way toward overcoming the prejudice against repeating weapons dating from the dismal failure of the Montigny Mitrailleuse during the Franco-Prussian War.

At the same time that U.S. inventors were striving to produce a reliable fast-shooting single-barreled gun, European engineers continued to improve volley-fire weapons. The Nordenfelt gun was invented by British engineer Helge Palmcrantz and financed by Thorsten Nordenfelt, a Swedish banker in London who put up the money and whose name was therefore attached to the gun. The Nordenfelt could be described as a mechanized battery gun that was essentially a hybrid of the Mitrailleuse and the Gatling gun. It was another multiple-barreled gun, but the barrels, which varied from two to 12, were mounted laterally side-by-side. In the three-barreled version, 27 brass cartridges were mounted on a wooden strip that could feed the gun at a rate of 350 shots per minute. Regardless of the number of barrels, the loading mechanism was essentially the same. An overhead hopper magazine carried as many columns of cartridges as barrels and delivered them into a carrier block operated by a hand lever. This lever was pushed forward to take the carrier block forward until the cartridges were lined up in their chambers. A breech block then moved forward to force the cartridges home, and an action block containing the firing pins moved in behind the breech block and lined up with the caps of the cartridges. At the end of the forward stroke of the handle, the firing pins were tripped, which fired the rounds. On the return stroke of the lever, the action block moved away, and the carrier block pulled clear and ejected the empty cases, moving back to

pick up a fresh load of cartridges. The greatest advantage of this gun was that it weighed only 13 pounds.

The weapon was first shown to a committee of Swedish and Norwegian military personnel in 1870–1877. This committee established a set of criteria for subsequent tests of the Nordenfelt that would serve as a model for the development and adoption of the machine gun, not only in Sweden and Norway but also throughout Europe and in the United States. These requirements would serve as design parameters for additional improvements to the machine-gun concept. They included:

1. Rapidity of fire (which should reach the rate of 300 or 400 rounds per minute).
2. The mechanism should not be easily put out of order, even if the rapidity of fire occasionally exceeded the normal standard.
3. The gun, with a considerable number of rounds (say, 4,000), should be capable of draught by two horses.
4. The piece should be readily separated, if necessary, from its carriage and be capable of conveyance by hand should the place desired be inaccessible to horses. No special tools should be required for this, save for a powerful screwdriver or hammer.
5. It should be furnished with an automatic apparatus for giving and regulating the horizontal spread of bullets, at various angles, and be capable of easy elevation throughout a sufficient height.
6. The ammunition used should, if possible, be interchangeable with that of the infantry.
7. Two men should be capable of performing all the duties of the piece when under fire.
8. Some sort of rangefinder should always be employed with the weapon.[13]

The Nordenfelt passed the test with flying colors. The Swedish-Norwegian Committee reported that the gun was capable of firing 450 rounds per minute and was very reliable, even under damp conditions and with less-than-thorough cleaning between firings. Despite the advantages, military authorities in most European armies still looked at machine guns with suspicion and were less than interested in the Nordenfelt gun for ground combat.

Another prominent weapon that combined U.S. technology and the Nordenfelt principle was invented in Toledo, Ohio, in 1876, by

William Gardner, a U.S. Army captain. Gardner sold his patents to a newly formed engineering company based in Hartford, Connecticut, Pratt and Whitney, later to become a leader in the field of aviation engineering. Francis Pratt had worked for Colt and knew something about firearms; between them, he and Gardner produced one of the best of the early mechanical machine guns. The Gardner gun originally included two (later models had five) barrels mounted side-by-side on a common frame. Each barrel had its own reciprocating bolt that was driven by a side crank and flywheel arrangement so that as one bolt was closed the other was opened. The weapon was loaded by the use of trays that contained 31 cartridges mounted on a wooden plank. This clip, or magazine, was fed vertically into the breech, and as the crank revolved a feed arm took one cartridge, positioned it in front of one of the breeches, and the bolt then closed and fired. As rotation of the crank continued, the fired cartridge was extracted and the feed arm fed the next cartridge to the other barrel in time for that bolt to close and fire.

The Gardner gun could fire either singly or at a speed of 120 rounds per minute depending on how fast the hand crank was turned. The major advantage of the Gardner gun was that it was portable (at least relative to other rapid-fire weapons of the era). With its tripod and 1,000 rounds of ammunition, the Gardner weighed less than 200 pounds and could be carried on a horse. Gardner demonstrated his gun for the U.S. Navy at the Washington Navy Yard in June 1879. He amazed onlookers by firing 10,000 rounds in 27 minutes, more than 300 rounds per minute, but the Navy purchased only a few units. The Army was not interested at all in the Gardner gun because ordnance officials apparently felt that the Gatling was sufficient for its needs. With little interest in the Gardner gun in the United States, the inventor took it to Britain, where he demonstrated it for the British Admiralty, then the British Army. Both services were impressed. The Royal Navy, looking for a lighter weapon capable of sustained fire that could be used on ships, adopted the Gardner in 1881 and used them extensively on torpedo boats, finding them of great value in the operations in Sudan and Egypt in 1884–1885. The British Army also adopted a tripod version for field use; these weapons were installed in coast-defense forts and remained in service until 1926.

Another promising attempt at developing a rapid-fire weapon was the Lowell, invented in 1875. The genesis of this weapon began much earlier. On 8 July 1856, the United States issued a patent to C. E. Barnes of Lowell, Massachusetts, for a crank-operated ma-

chine cannon that had many original features. Developed by DeWitt Clinton Faringdon, who set up the Lowell Manufacturing Company to make it, the Lowell gun consists of a cluster of four barrels with a locking system that employs a toggle-joint arrangement that rams home a fixed charge. The stiff linen cartridge was fed from a tray located on the left side of the breech of the gun. A percussion cap was placed on the nipple mechanically after the weapon was safely locked; these caps were fired by a continued forward movement of the crank action, which tripped a sear. Gas pressure from the explosion in the chamber was used to cock the hammer for the next round to fire. A crank was turned, bringing the next barrel into firing position. The rate of fire depended solely upon the speed the crank was turned. This weapon was far ahead of its time, and its development would have placed a reliable machine gun in the armed forces several years prior to the Civil War.

However, it was not until 1876 that Faringdon was able to interest the U.S. Navy in his gun. After he successfully demonstrated the weapon and made some small modifications, the gun was tested for the Navy. This weapon used a reciprocating breech block rather like that of the Gatling and had three barrels, but it only fired through one. Once that barrel became hot, the second barrel was rotated into place, and firing began again; when that became hot, the third barrel was used. The Lowell gun was very well made, and during a two-day test 50,000 rounds were fired with only two stoppages. This weapon may have had a future, but the United States was not at war, and there was not even the slightest indication of trouble in the near future, so there was little impetus to fund its development and adoption. Faringdon sold a handful of Lowell guns to the Navy, 20 to Russia, and several to the California Prison Service and the Cincinnati Police Force. Having no further luck in marketing the gun, Lowell's company collapsed, but not before Faringdon had contributed certain basic principles of design that were used for many years after the demise of the Lowell gun.

Many advancements were made in machine-gun technology during and following the Civil War. All these weapons were manually operated by a crank, a mechanism that enables the gunner to maintain sustained fire with a minimum of effort. The most advances in the development of the manual machine gun were U.S. in origin, due primarily to the advanced state of the U.S. machine-tool industry. However, by 1880 the manual machine gun had gone about as far as it could. The weapons had reached a high degree of efficiency, and so it was predicted that nothing was left to be improved. They

were accepted as invincible reapers of death. However, Hiram Maxim, another U.S. inventor, soon appeared on the scene. With that, the idea of the mechanical machine gun was as good as dead, proving that today's invincible weapon can very quickly become tomorrow's obsolete scrap.

NOTES

1. Ian V. Hogg, *Machine Guns: 14th Century to Present* (Iola, WI: Krause, 2002), p. 15.

2. Ibid.

3. Terry Gander, *Machine Guns* (London: Crowood Press, 2003), p. 12.

4. Ian V. Hogg, *Machine Guns* (Iola, WI: Krause Publications, 2002), p. 292.

5. George M. Chinn, *The Machine Gun: History, Evolution, and Development of Manual, Automatic, and Airborne Repeating Weapons* (Washington, DC: U.S. Department of the Navy, 1951), vol. 1, p. 43.

6. Quoted in John Ellis, *The Social History of the Machine Gun* (Baltimore: Johns Hopkins University Press, 1975), p. 27.

7. Quoted in P. Wahl and D. R. Toppel, *The Gatling Gun* (London: Herbert Jenkins, 1966), p. 21.

8. Robert L. O'Connell, *Of Arms and Men: A History of War, Weapons, and Aggression* (New York: Oxford University Press, 1989), p. 233.

9. Trevor N. Dupuy, *The Evolution of Weapons and Warfare* (New York: Bobbs-Merrill, 1980), p. 200.

10. Theodore Ropp, *War in the Modern World* (Durham, NC: Duke University Press, 1959), p. 145.

11. Quoted in Anthony Smith, *Machine Gun: The Story of the Men and the Weapon That Changed the Face of War* (New York: St. Martin's, 2002), p. 66.

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13. Quoted in Roger Ford, *The Grim Reaper: The Machine-Gun and Machine-Gunners* (New York: Sarpedon, 1996), pp. 11–12.

CHAPTER 3

The Maxim Guns

Hiram Stevens Maxim, the first man to connect the words "automatic" and "machine gun," was born on 5 February 1840 at Brockway's Mills, near Sangerville, Maine. At the age of 14, Maxim was apprenticed to a carriage maker. A self-educated man, he studied whatever scientific books he could find. With a talent for drawing and printing and a facility for handling tools, he soon became adept at several trades, working in a shipbuilding yard and in a machine shop. After a variety of jobs, he settled down in 1865 with a company in Boston that manufactured automatic illuminating gas machines. He later opened his own business in New York, the Maxim Gas Machine Company, specializing in the fields of gas generating plants, electric lighting, engine governors, and steam and vacuum pumps. His company installed the first electric lights used in New York City in the Equitable Insurance Building, considered to be the most modern building in the world in its day.

BACKGROUND

In 1881, while attending the Electrical Exposition in Paris, this self-described chronic inventor became fascinated with the fact that almost every inventor in Europe seemed to be attempting to perfect some sort of machine gun.[1] According to a story he later told repeatedly, an acquaintance at the exposition told him, "Hang your chemistry and electricity! If you wish to make a pile of money, invent something that will allow these fool Europeans to cut each other's

throats with greater facility!"[2] The idea of a machine gun was not new to Maxim. He had conceived of such a weapon in 1854, but suitable cartridges had not yet been developed, and the idea went nowhere. By the 1880s, however, the concept of automatic fire was more practical. Already interested in the potential for a workable machine gun and heeding his friend's advice, Maxim went to London, opened a workshop, and began to study firearms. This was a smart move because the United States was at peace and its military was not very encouraging to domestic weapons designers. Europe, however, was another case. The Franco-Prussian War had ended just 10 years before and settled little; Europe was a steaming cauldron of assorted entities, and no one was sure when the next conflict might erupt. Thus, Europe was fertile ground for someone setting out to develop a new weapon.

Between 1883 and 1885, Maxim patented practically every conceivable method of obtaining automatic fire. His first patent, registered on 16 July 1883, was for "an invention of improvements in machine or battery guns, and in cartridges for the same and other firearms."[3] He later said that this first patent evolved from an observation that he made during target practice with a Springfield service rifle, which, when fired, left his shoulder bruised. He saw that when the rifle was discharged, an enormous amount of energy was released, only a small portion of which actually drove the bullet out the barrel; the rest of the energy went into the powerful recoil. Thinking this a tremendous waste of energy, he asked himself, "Cannot this great force, at present merely an inconvenience, be harnessed to a useful purpose?"[4] Accordingly, Maxim set about to take advantage of the great power of the recoil forces to drive the entire cycle of operation for a weapon. Using this principle, which he called blowback, the inventor devised a fully automatic rifle that was fed by a revolving magazine.

DEVELOPMENT OF THE FIRST MAXIMS

Drawing on the idea behind his first automatic rifle, Maxim set out to develop a new machine gun that could load and fire itself as long as the trigger was held back—a pioneering feat that would eventually win him knighthood. Using the same recoil forces that operated his rifle, he sought to convert the hand-cranked machine gun into a truly self-powered automatic weapon. The introduction of smoke-

less powder in the 1880s assisted Maxim in making his ideas a reality, primarily because smokeless powder's even combustion made it possible to harness efficiently the recoil in order to push back the bolt and extract the spent cartridge. In Maxim's design, this rearward action by the bolt compresses a spring, which causes the bolt then to accelerate forward, bringing a new round into position for firing. Using what became known as the short recoil system, Maxim demonstrated his first working model in 1884. It weighed more than 60 pounds and was chambered for the British Army caliber .45 Martini-Henry cartridge. It was significantly different from any weapon previously developed and represented a tremendous leap forward in the evolution of the machine gun.

Prior to this time, all machine guns had been loaded either by a mechanical feed worked by the operator with a handle device, or by the weight of the cartridges falling one by one into position from a gravity-feed hopper above the gun. Almost without exception, these weapons consisted of from two to 20 barrels. They were powered by some outside force, usually by a man operating a crank or lever of some sort. Maxim's invention revolutionized the machine gun, producing a single-barrel weapon that was self-loading and self-ejecting. Thus, the major difference between Maxim's invention and the mechanical machine guns—in which the rate of fire depended on how fast the gunner could turn the crank—was that his weapon essentially loaded and fired itself while the trigger was depressed until the ammunition was spent.

When the gun had a cartridge in the chamber and was ready to fire, the breech block was firmly held against the rear of the barrel by a large hook. When the weapon was fired, barrel and breech recoil in the gun body about a half-inch, after which the hook lifted, the barrel stopped moving, and the breech block was free to continue its backward movement, extracting the spent case. The block was attached to a connecting rod and flywheel crank. As the block recoiled it drove the flywheel around about three-quarters of a rotation, so that the energy imparted to the flywheel caused it to drive the block back, fed a fresh cartridge into the breech, force the barrel forward, and allow the hook to drop and lock the weapon again. The flywheel stopped and the firing pin was released to fire the cartridge. The recoil from this shot drove the flywheel in the opposite direction, once more completing the entire cycle of extraction, feeding, and firing.

Now only one gunner had to press a trigger to send out a spray of bullets. The weapon fired as long as the trigger was pressed and ammunition was fed into it. The only assistants needed were those re-

quired to bring forward additional ammunition belts. The Maxim was a huge leap forward in killing efficiency and would forever change the battlefield.

With the ability to fire rapidly for sustained periods, Maxim confronted the old problem of heat buildup. To counter this, he invented a water jacket that was placed around the barrel, which would transfer the heat to the water and cool the barrel. After 600 rounds were fired, the water would begin to boil and evaporate. Therefore, a supply of 1.5 pints of water was needed for every 1,000 rounds fired. In addition to adding the water-cooled barrel, Maxim also mounted his weapon on a tripod instead of on wheels.

In January 1885, Maxim demonstrated the gun before Lord Wolseley, Duke of Cambridge, the commander in chief of the British Army. The duke was impressed, but other observers in Wolseley's party told the inventor that he would have difficulty selling his weapon until he lightened the weight and simplified the design. One of the observers, Lieutenant General Sir Andrew Clarke, inspector general of fortifications, advised the inventor to keep working on his gun: "Do not be satisfied until it can be disassembled, examined, and cleaned with no other instrument than the hands."[5]

IMPROVEMENTS IN DESIGN AND PERFORMANCE

Maxim went back to his workshop and dedicated himself to improving the weapon and making it lighter, simpler, and more reliable. Within three months, he completed a major overhaul of the original design. The weapon, reduced to just over 40 pounds in weight, still used recoil as the driving force, but Maxim replaced the flywheel crank with a toggle-type lock that greatly simplified the extraction, feeding, and firing cycle. This improved design was so effective that it was to serve largely unchanged in some armies until World War II.

In another major innovation, Maxim improved the feeding mechanism by devising a cloth belt stitched into pockets, each pocket carrying a cartridge. The movement of the block extracted a cartridge from the belt, fed it down in front of the chamber, and moved the belt one cartridge at a time. As long as the gunner pressed the trigger and the belt was long enough, the Maxim gun could fire indefinitely, deriving its energy anew from every shot it fired.

Even though Maxim made the modifications requested by the British Army, something that resulted in a much better weapon, he still met resistance. In European armies, most officers came from the landowning classes; left behind by the Industrial Revolution, they still thought of war in terms of the bayonet and the cavalry charge. They clung to their belief in the centrality of human power and the decisiveness of personal courage and individual endeavor; after all, one did not pin a medal on any gun. Additionally, they thought that the machine gun was an uncivil weapon to use against European opponents. Thus Maxim changed his approach and began to market the weapon for use in the colonies to pacify native colonial populations. Inevitably, cases of slaughter by machine gun among the major powers' far-flung colonies tainted the weapon, making it even less palatable for European warfare in the eyes of many officers holding traditional ideas toward combat and warfare.

MAKING THE ROUNDS

Undaunted by squeamishness among potential customers, Maxim traveled Europe while demonstrating his weapon. He was accompanied by Albert Vickers, a steel producer from South Kensington who had become intensely interested in Maxim and his invention. In 1887, Maxim took one of his guns to Switzerland for a competition with the Gatling, the Gardner, and the Nordenfelt. It easily out-shot all competitors. The next trials were in Italy at Spezzia. There the Italian officer in charge of the competition requested Maxim to submerge his gun in the sea and allow it to be immersed for three days. At the end of that time, without cleaning, the gun performed as well as it had before being subjected to this officer's unusual demand. The next trial was in Vienna, where an impressed Archduke William, the field marshal of the Austrian Army, observed that the Maxim gun was "the most dreadful instrument" that he had ever seen or imagined.[6] History would prove the archduke's observation to be only too true.

Many observers were first skeptical toward Maxim's claim that his weapon could fire 10 shots per second and maintain that rate of fire for any extended length of time. At the Swiss, Italian, and Austrian trials and those that followed, Maxim made believers out of all who saw the weapon in action. One exception was the king of Denmark, who was dismayed at the expenditure of ammunition and decided

that such a weapon was far too expensive to operate, saying that it would bankrupt his kingdom.

In 1888, Maxim formed a partnership with Vickers, an association that would last until Maxim's seventy-first birthday. Having successfully demonstrated his weapon in Europe, Maxim and his new partner began producing the machine gun. The first production model was capable of firing 2,000 rounds in 3 minutes. It was very well built, easy to maintain, and virtually indestructible. By 1890, Maxim and Vickers were supplying machine guns to Britain, Germany, Austria, Italy, Switzerland, and Russia.

THE MAXIM IN BATTLE

The first recorded combat use of the Maxim was in the British colony of Sierra Leone on 21 November 1888. A small punitive expedition under General Sir Francis de Winton was sent out to deal with a tribe that had been raiding various settlements. The British troops took with them a caliber .45 Maxim gun that de Winton had purchased. Using the Maxim, the British troops rapidly routed their opponents at the fortress of Robari. A contemporary report in London's *Daily Telegraph* noted that the "tremendous volley" of fire caused the tribesmen to flee for their lives; it further stated, "Such was the consternation created by the rapid and accurate shooting of the gun that the chief war town was evacuated, as well as the other villages of the same nature, and the chiefs surrendered, and are now in prison."[7]

The British Army adopted the Maxim in 1889, originally in caliber .45 but later in caliber .303. The Maxim changed the equation in colonial battles, giving the Europeans a decisive advantage. One of the first uses of the new weapon after its official adoption by the British Army was by colonial forces in the Matabele War of 1893–1894 in the Northern Transvaal of South Africa. A detachment of 50 British infantrymen with four Maxims defended themselves against 5,000 native warriors who charged them five times over 90 minutes. Each time, the charges were stopped about 100 paces in front of the English lines by the devastating Maxims. It was recorded that 5,000 dead lay in front of the English position after the battle.

Maxims were also used effectively by British colonial troops on the Afghan frontier during the Chitral campaign of 1895 against the

mountain tribesmen of the Hindu Kush. Elsewhere, the Maxim continued to make a name for itself. In 1898, at the Battle of Omdurman in the Sudan, the disciples of the Mahdi, the fabled Dervishes, repeatedly hurled themselves against British lines, only to be repulsed each time by six Maxim guns firing 600 shots per minute. "It was not a battle, but an execution," reported G. W. Steevens. "The bodies were not in heaps ... but ... [were] spread evenly over acres and acres."[8] Another British observer proclaimed, "To the Maxim primarily belongs the victory which stamped out Dervish rule in the Sudan."[9] It is doubtful that Lord Kitchener and his troops could have prevailed without the Maxim guns.

Still, the weapon was not without its limitations. The Maxims were not well-suited for mobile warfare in mountains and jungles, where the enemy could fight dispersed or become invisible. There were also difficulties in effectively employing the weapons; pushed too far forward, they might become isolated and their crews overwhelmed. Also, the Maxim, at this point in its development, was not free of mechanical problems and had a tendency to jam at the most inopportune times.

Nevertheless, the Maxim in the hands of British troops proved successful in colonial campaigns on the Indian frontier, in the Sudan, and in Africa. Still, progress in selling the army at home in Britain on the utility of the machine gun was very slow. This suggested that military authorities were not yet convinced of its applicability to more traditional concepts of warfare due to the limitations of the weapons. The British War Office exhibited little interest, regarding it as useful in warfare against colonials but having little utility on the civilized European battlefield. Such an attitude would inhibit the consideration of new tactics and doctrines to make the most efficient use of these deadly weapons.

LATER MODELS AND DERIVATIVES

Maxim continued to perfect his weapon. In 1904, he produced a new model that was the first gun to bear the name Vickers along with Maxim. The Vickers was stronger and more reliable than its predecessors. Maxim's weapons were adopted by every major power in the world at one time or another between 1900 and World War I.

The success of the Maxim gun inspired other inventors, and guns

based on its principles appeared in armies in Germany, Russia, the United States, and other nations. The weapons that would have such a devastating impact on the battlefields of World War I were, largely, direct descendants of the first Maxim design.

THE BROWNING

One of these inventors was John M. Browning, born on 21 January 1855 in Ogden, Utah. In 1879, the young inventor, who would become one of the most prolific weapons designers in history with 128 patents and more than 100 different weapons to his credit, developed a single-shot dropping block–action rifle in 1879, which he sold to Winchester. In 1884 Browning secured patents on a lever-action rifle, which he also sold to Winchester; this became the famous Winchester Model 1886 Rifle, the first lever-action rifle of the day. Additionally, he developed other weapons, including a lever-action shotgun, a pump-action shotgun, and a semiautomatic high-powered rifle.

Browning became interested in automatic weapons in 1889. Rather than relying on Maxim's idea that the weapon's recoil could work the extraction, feeding, and firing cycles, he was of the opinion that the escaping gas of the muzzle blast could be harnessed as a source of energy. His first test model used a perforated plate in front of the muzzle. The bullet went through the hole in the plate, but the spreading blast hit the plate and, via various levers and cranks, operated the breech to reload the gun and fire the next shot. This was cumbersome, so Browning drilled a hole in the barrel just below the muzzle. Beneath the barrel he affixed a hinged arm, the tip of which lay beneath the hole, so that the emerging gas forced the end of the arm down and, by levers, operated the breech. By 1890 he had perfected this design and offered it to Colt, which built a working model. The weapon, which became known as the Colt Model 1895, was the first purely gas-operated machine gun. It was also the first fully automatic machine gun purchased by the U.S. government. Adopted by the U.S. Navy in 1895, the weapon had to be used on a tripod or other high-set mounting in order to keep the swinging arm from digging into the ground. For that reason, the gun became known as the Potato Digger. This was not a serious drawback at the time, because no one had yet thought about men crawling around

the battlefield with machine guns. The Model 1895 was first used in limited numbers in combat by U.S. Marines at Guantanamo Bay, Cuba, in 1898.

The First Blowback Guns

While Maxim and Browning worked to perfect their designs, other machine-gun designers were at work in Europe. In Austria in 1888, Archduke Karl Salvator and Colonel von Dormus patented a very simple gun using the blowback system. This gun was unique in that it did not have a breech lock. Because of that, it could use only relatively weak cartridges. Nevertheless, the design was sold to the Skoda company of Pilsen, where it was manufactured as the Skoda Mitrailleuse Model 1893 Machine Gun. Later modified as the Skoda Model 1909, this weapon remained in service in the Austro-Hungarian Army through World War I, during which it was primarily used for fortress defense.

In 1893, another Austrian, Captain Baron Adolph von Odkolek, took his idea for a gas-operated machine gun to the Hotchkiss company in France. Laurence V. Benet, manager of the Paris company, bought the design from Odkolek and began manufacturing the guns in great numbers. Like the Browning machine gun, the Hotchkiss used some of the gas that pushed the bullet through the barrel. The gas escaped through a port drilled in the barrel and was directed into a cylinder underneath, driving a piston back to unlock and withdraw the breech block, loading a spring, which then pushed the breech block and piston back while loading a fresh cartridge. The ammunition for the Hotchkiss was on a pressed metal strip into which 20 cartridges were affixed. The clip was fed into the left side of the weapon, and rounds were stripped out by the action of the piston, which also advanced the ammunition strip. The first prototype of the Hotchkiss did not perform very well, but Benet made some modifications, and the gun was adopted by the French Army in 1897. With Benet's changes, the gun worked reasonably well yet was prone to overheating, even though it had massive brass fins along the barrel to dissipate heat. A later model had steel fins, which helped slightly with heat buildup, but the French Army was still dissatisfied with the weapon, so it set out to improve the design without Hotchkiss's assistance. The first attempt, made by the arsenal at Puteaux in 1905, was not much of an improvement and was not

adopted as a field weapon; the French continued to use the original Hotchkiss gun.

COLONIALISM AND THE FIRST LESSONS OF MODERN WAR

While inventors worked on perfecting the automatic machine gun, the first real test on the modern battlefield occurred during the South African War (1899–1902) between the British Army and the Boers. This was the first war in which both regular armies composed of white troops used Maxim guns. The British fielded a regular army composed of 23 battalions of cavalry, 18 of mounted infantry, and 96 of foot infantry supported by artillery. They were opposed by a force made up of virtually every able-bodied man and boy in the Transvaal and Orange Free State. The British fought in the traditional way, "a strict choreography hardly changed from Waterloo or even Blenheim."[10] The Boers, by contrast, fought from horseback and, using their hunting skills and knowledge of the terrain, very effectively conducted hit-and-run tactics against the British formations.

The British had one or two Maxims per battalion, and the Boers had been purchasing Maxims for years. The British did not change their style of warfare and failed to take advantage of the machine guns they had. Such was not the case for the Boers. When the British tried to attack at Magersfontein and Colenso, the Boer Maxims mowed them down. Even at Colenso, which was nominally a British victory, 1,500 British troops were killed or wounded. Despite all this history, there was no fundamental reevaluation by the British of tactics for facing these modern weapons deployed in a defensive position. The British high command appeared oblivious to the now obvious lessons of trying to attack a fortified position defended by Maxim guns. As historian Roger Ford points out, it was "a small-scale rehearsal for what would happen in Europe fifteen years later."[11]

If the Boer War failed to bring home any significant lessons, the Russo-Japanese War of 1904–1905 provided another opportunity to see what modern weapons could do. Prior to the outbreak of hostilities, the Russians had purchased vast numbers of Maxim and Vickers guns and organized them into machine-gun companies. When fighting broke out, machine guns quickly demonstrated their deadly

utility, as well as the value of using large numbers of machine guns in both offense and defensive operations. The new impact was apparent at the Battle of the Yalu River, where eight Russian Maxims beat off several Japanese attacks while inflicting heavy casualties. In August 1904 at the Battle of Shokozan Hill, the Japanese lost 540 to machine-gun fire. Later that month, the Japanese attacked the Banriusan East Works at Port Arthur, losing about 50 percent of the attackers to Russian machine guns.

The Japanese had also armed themselves with machine guns. Having purchased the Hotchkiss gun from the French, they used the lighter weapon in an innovative fashion, carrying them forward during attacks to provide firepower for the infantry. The Japanese became very adept at covering assaults by firing over the heads of their own attacking troops to keep down the defenders. At the Battle of Sha-Ko, the Japanese used six Hotchkiss guns against two Russian battalions. One observer wrote, "In less than one minute hundreds of these poor fellows [Russians] were killed, and the rest flying eastward in wild disorder."[12]

Throughout the hostilities, the Russians continued to rely on the Maxim and Vickers guns, but they also used a light machine gun (LMG), the Madsen. The designation of a weapon in the LMG category was not based entirely on weight; it also mattered how the gun was used. The Maxim and Vickers guns, both relatively heavy, were designed to be used on tripods or wheeled carriages. Normally, the early machine guns were brought into position before the battle opened so that they could provide covering fire for the infantry. Once the battle began and the lines became more fluid, the machine guns normally fell silent in order to keep from firing on friendly troops as they maneuvered in front. Thus a light machine gun, operated by one or two soldiers, was needed to move along with the attacking infantry, providing direct fire support as they moved on the battlefield. The Madsen, which had originally been designed as an automatic rifle by a Danish officer named Jens Schouboe, proved too cumbersome to be used in that role by the Russian infantry, but it served fairly well as a light machine gun. Named after the Danish minister of war, the Madsen was a recoil-operated weapon that essentially adapted the rising-block breech of the Martini rifle to automatic fire.

In addition to its use by the infantry, the Madsen was also carried on horseback by the Russian cavalry. Although the rising-block action was complicated, the weapon was very reliable, and for that reason it was produced and used by different armies without major

changes for more than 50 years. At various times over its service life, it was used as an infantry weapon, a tank gun, and as aircraft armament—all with equal success.

There were observers from all the major powers during the Russo-Japanese War. Many of them, like John J. Pershing of the United States, sent home their observations, describing the nature of the fighting and noting, among other things, the effectiveness of machine guns on the battlefield. However, their dispatches were largely ignored or, as historian Robert O'Connell wrote, "were selectively interpreted in a manner which screened out the enormous power of field entrenchments, the deadliness of machine guns and quick firing artillery, and the futility and inevitability [of] huge casualties accompanying frontal assault." Further, he writes that "this prelude to Armageddon passed if not unnoticed, then at least thoroughly misunderstood by the military establishments which, in less than a decade, would have to suffer the consequences."[13] As in the Boer War, the signals were there, but very few interpreted them correctly.

The lessons of the Russo-Japanese War were not lost on all nations. All saw the devastation wrought by the machine gun, but some observers were more impressed than others. German officers, seeing the deadliness of the Maxim and Vickers guns employed by the Russians, realized the ramifications for the battlefield and subsequently recommended that the Maxim be adopted by the army. Soon Maxim guns were being built in Germany under license from the Vickers-Maxim company in London. (The Maxim Gun company was absorbed by Vickers to form Vickers Sons and Maxim Limited, with Maxim serving as a director. The name of the company was changed to Vickers Limited in 1911.)

PRE–WORLD WAR I DEVELOPMENT

Germany

While Germany's army was buying Maxims, its designers were already at work on domestic weapons. Louis Schmeisser, working for Theodor Bergmann, patented and produced his first prototype in 1901. It was a recoil-operated weapon with a water jacket around the barrel to prevent heat buildup. The following year, Schmeisser redesigned the prototype, shortening the barrel and adopting a form

of belt-feed. Schmeisser parted company with Bergmann, but his son, Hugo, remained in the company and carried forward with his father's work. In 1908, the German Army, wanting to broaden its procurement base, decided to adopt another machine gun in addition to the Maxim. In response, Bergmann produced a modified design that used the Maxim feed mechanism and fired from a closed bolt; this weapon was designated the Model 1910. The army accepted the gun in principle, but it was not until the outbreak of World War I that the gun went into major production as the Model 1915.

The Germans also produced a heavy Maxim gun designated the Maschinengewehr (Machine Gun) 08 (MG08), which was developed at the government armory at Spandau and was distributed to German infantry units. By the start of World War I, they would have a large number of these guns ordered or on hand. The MG08 was a heavy, solid gun and, like all Maxim-type guns, was very reliable. During World War I, it would take such a fearsome toll that the Versailles Treaty prohibited Germany from developing water-cooled heavy machine guns (HMGs).

By 1907, the Austro-Hungarian Army had become disenchanted with its Skoda machine gun and turned toward a new model invented by the German designer Andreas Wilhelm Schwarzlose. His design, first patented in 1900, employed a blowback system in which the gun was operated by the rearward movement of the breechblock. The Schwarzlose, first introduced in 1905 and manufactured by Steyr in Austria, was cheap, simple to understand and operate, and solid and robust. In fact it was so heavy that the parts never seemed to wear out, and many of the Austrian guns used in the coming war would be around for use in World War II. It was also sold to the Netherlands, Greece, Serbia, Romania, Bulgaria, Turkey, and Sweden.

Other Developments

The story of the machine gun in the years between the end of the Russo-Japanese War and the outbreak of World War I in Europe follows two tracks. One traces the technical development and evolution of the automatic machine gun and associated weapons. This story is one of inventors finding ways to improve the gun. The other track deals with military doctrine and the tactical deployment of the machine gun on the battlefield. The development of the machine

gun was straightforward as inventors continued to perfect it. The doctrinal debate was much more problematic and ultimately led to tragic consequences.

As for the technical aspects of machine-gun development, it is clear that by the early 1900s the most ubiquitous machine gun in armies around the world was the Maxim, already in service for some 20 years. Although the machine gun had been proven on the battlefield, armies continued to improve the design, primarily focusing on making it lighter through the careful choice of materials and by reducing some physical dimensions. The result in Great Britain was the Vickers, first introduced in November 1912. It was a tripod-mounted, water-cooled weapon that was very reliable and is capable of firing continuously for long periods. However, because of the intense heat, the barrel quickly becomes inoperable. Heavy fire demanded a replenishment of the water supply to cool the barrel, and there are many stories of machine gun teams using up all the water around their positions and having to urinate on the weapon to cool it down.[14] A sound design, the Vickers was very popular with the troops. It became the standard-issue weapon in the British Army and earned itself the nickname the Queen of the Battlefield. It would continue to serve from 1912 until the 1960s, with very little modification.

The French were also busy and continued to improve the Hotchkiss design. One result was the Model 1907, manufactured at the Saint Ètienne arsenal. This weapon could best be described as a Hotchkiss with everything changed merely for the sake of changing it. For example, the weapon employed a conventional gas piston, but in an unconventional way. Instead of the gas-driven piston thrust rearward, which provided the energy to operate previous weapons, in this weapon the piston was blown forward to unlock the bolt. To do this the direction of motion had to be changed by a gear system in order to move the breech block backward. The only original Hotchkiss design aspect they retained was the strip-feed system, the most serious defect in the Hotchkiss gun. The Saint Ètienne version was first used in combat in 1914. It proved to be a mechanical disaster, with shortcomings too numerous to overcome; it was generally abandoned by the French Army in favor of the original Hotchkiss design in the form of the Modèle 1914, which was heavy and awkward to load but reliable enough to see widespread service during World War I and into World War II.

The Russians, who had seen and experienced the effects of Maxim's guns firsthand in 1905, developed their own version in the

form of the Pulemet Maksima Obrazets (Maxim-Type Machine Gun) 1910 (PM1910), one of the longest-lived copies of Maxim's original design. Five years in development, the PM1910 was heavily constructed with a steel water jacket and was mounted on a small artillery carriage with wheels. Because of its construction, it could take rough handling, was able to absorb punishment, and operated well in difficult conditions and climates. The PM1910 would see service in World War I and also World War II, as many were still in service in 1939.

By 1910, machine-gun designs shared several common characteristics. Regardless of origin, they were belt-fed, water-cooled, and mounted on a tripod. However, one of the motivations that kept inventors busy before World War I was the need for a light machine gun that could be carried by one man on the attack. The Maxim- and Vickers-class guns required a crew of three, due to the weight, the belts of ammunition required, and the cumbersome mounting. The use of the first light machine gun, the Madsen, by the Russians against Japan demonstrated the utility of a light machine gun that could be taken forward by the infantry and brought into action during an attack. Significant efforts were made to produce a lighter version of the machine gun.

At Hotchkiss in Paris, Lawrence Benet and his chief experimental engineer, Henri Mercié, developed a light machine gun that used a unique mechanism known as the Fermeture Nut to lock the breech, so making the mechanism more compact and lighter. Hotchkiss had studied the performance of the Madsen guns with the Russian cavalry during the Russo-Japanese War and set out to scale down the standard Hotchkiss. Introduced in 1909 as the Hotchkiss Portative, this weapon was received with great interest in the cavalry community, which had long wanted a light machine gun that could be used on horseback. French and British cavalry both adopted the Light Hotchkiss, and the U.S. Army bought a number, calling it the Benet-Mercié Machine Rifle M1909. Outside the cavalry, this weapon generated little interest until the outbreak of World War I, when it became a hot property. It would remain in use until the late 1940s by French and British reserve forces.

The most significant new light design was pursued by two Americans. Early in 1907, Samuel McClean and Lieutenant Colonel O. M. Lissak of the U.S. Army had begun to design a gas-operated light machine gun. McClean was a doctor from Cleveland. He practiced medicine for eleven years, but then found he was more interested in inventing things. Echoing some of the sentiments of another inven-

tive doctor, Gatling, McClean wrote: "A machine gun is a noble thing as the mechanism which accomplished the greatest amount of human destruction in the shortest possible time with the least difficulty.... [It] may make war obsolete, for what rational man would throw his life away senselessly in front of one."[15]

With this somewhat dubious justification in mind, McClean and Lissak developed several prototype weapons, describing them as *automatic rifles*. They tried to interest the U.S. Army in their weapon. Despite the fact that the gun was well-finished and more compact than most other models of the time, McClean and Lissak were unable to make any headway with ordnance officials. Accordingly, they sold the design and patents to the Automatic Arms Company of Buffalo, New York, which in turn approached Lieutenant Colonel Isaac Newton Lewis of the U.S. Army in 1910, asking to see if he could turn the patents into a usable gun. Many experts think that McClean does not get enough credit for pioneering the light machine gun because the gun resulting from his original designs would be forever associated with Lewis. Using the McClean-Lissak designs, Lewis modified the air-cooling system and transformed it from a tripod-mounted, water-cooled medium machine gun (MMG) into a shoulder-fired, air-cooled light model. Working with the engineers at Automatic Arms, he produced five working guns in 1911. He successfully demonstrated the weapons to the U.S. secretary of war, the chief of staff, and other senior officials at Fort Meyer, Virginia, and then turned over four guns to the Board of Ordnance.

At the time the chief of ordnance was General William Crozier, an autocrat who believed that only the Ordnance Department knew anything about weapons development and that any new weapons had to be developed by ordnance personnel in an ordnance facility. He took great umbrage that Colonel Lewis, not a member of this close-knit community, had worked on the gun while serving as an officer in the U.S. Army. This is ironic because Crozier himself was getting royalties from a gun carriage that he had designed several years earlier while on active duty. Although Lewis resigned his commission in 1913, he could not overcome Crozier's resistance, and the new weapon was rejected out of hand with only the most perfunctory trial. Lewis then took back his guns and went to Belgium, where he set up a company called Armes Automatiques Lewis to manufacture it.

The Lewis gun was an excellent weapon. Gas-operated, it was fed from a circular, 47-round drum that was fitted onto a post on top of

the gun. The barrel was surrounded by a tubular jacket covering aluminum fins; as the gun fired, the muzzle blast drew air forward through the back end of the jacket, passed it over the fins to cool the barrel, and finally ejected it out the front of the jacket. It was much lighter than the Vickers and could be carried into battle and fired by one man.

Ultimately, Lewis licensed the Birmingham Small Arms Company (BSA) in Britain to make the weapon. When war broke out, the entire production capacity of BSA went into making Lewis guns for the Belgian Army, then for the British and Italian Armies. Given the need for a light machine gun, BSA production could not keep up with demand, so the Savage Arms Company of Utica, New York, was given a contract, and by 1917 it was turning out 400 guns per week. One of the Lewis's great advantages was that it was easy to manufacture: six Lewis guns for every one Vickers gun.

The Lewis became the standard light machine gun for the armies in Great Britain and Belgium. It was a sound design, so much so that 50,000 British Lewis guns in reserve stocks were brought back into service when World War II broke out. Although the U.S. Marine Corps equipped itself with Lewises, the U.S. Army never adopted it, primarily because of the continuing clash of personalities between Lewis and General Crozier, who as chief of ordnance had the final say on what weapons the U.S. Army purchased.

CONCLUSION

As the armies of the world lurched toward the first volleys of World War I, all were armed with machine guns. However, the important questions remained: How would they be used on the battlefield? How would they be distributed within military formations? And how would they affect tactical operations? None of these questions had been adequately answered. It would take four years of bloodshed on the battlefields of Europe to shape the answers to these questions.

NOTES

1. Anthony Smith, *Machine Gun: The Story of the Men and the Weapon That Changed the Face of War* (New York: St. Martin's, 2002), pp. 81-82.

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3. Quoted in G. S. Hutchison, *Machine Guns: Their History and Tactical Employment* (London: Macmillan, 1938), p. 49.

4. Quoted in George M. Chinn, *The Machine Gun: History, Evolution, and Development of Manual, Automatic, and Airborne Repeating Weapons* (Washington, DC: U.S. Department of the Navy, 1951), vol. 1, p. 128.

5. Ibid., p. 131.

6. Ibid., p. 137.

7. Quoted in Ian V. Hogg, *Machine Guns: 14th Century to Present* (Iola, WI: Krause, 2002), p. 39.

8. G. W. Steevens, *With Kitchener to Khartoum* (New York: Hyperion Books, 1990), p. 300.

9. Hutchison, *Machine Guns*, p. 70.

10. Roger Ford, *The Grim Reaper: The Machine-Gun and Machine-Gunners* (New York: Sarpedon, 1996), p. 55.

11. Ibid., p. 57.

12. Quoted in Hutchison, *Machine Guns*, p. 85.

13. Robert L. O'Connell, *Of Arms and Men: A History of War, Weapons, and Aggression* (New York: Oxford University Press, 1989), p. 237.

14. Craig Philip, *The World's Great Small Arms* (London: Amber Books, 1993), p. 65.

15. Quoted in Smith, *Machine Gun*, p. 246.

CHAPTER 4

Machine Guns During World War I

There were many technological advances in the years immediately preceding the outbreak of World War I. Yet the appreciation of the new technology and associated doctrine and tactics lagged behind the technology itself. Not all armies foresaw the impact that the weapon would have on the battlefield. Generally, at the beginning of the war, the machine gun was viewed as a support weapon for the infantry. The usual distribution was two weapons for each infantry battalion, used to provide supporting fire during the attack and as a reserve for the riflemen in the defense, thickening the battlefield along the main enemy avenues of approach. In one sense, they were still treated as pieces of artillery and put along the flanks to provide enfilade fire (where the line of fired was parallel to the enemy's line of advancing troops). Despite these general tendencies, the machine gun was not viewed the same in every army.

TRENCH WARFARE

The war in Europe during the period 1914–1918 would be one of firepower. The two sides on the Western Front became locked into two lines of entrenchments, and any advance had to be simply a matter of overwhelming the other side with firepower so as to open a gap for the attackers to march through. Historian Ian V. Hogg has

likened the war on the Western Front to "a great siege, in which the Allied powers—mainly Britain, France, and later, the United States—were trying to break into the fortress which was Germany; and the principal reason for the war taking this turn was the use of the machine gun."[1] Hogg further points out that after the German Army's Race to the Sea was thwarted, the power of the machine gun began to dominate no-man's land, shaping the tactics of both sides.

However, this was not apparent to all belligerents at first. By 1914, when World War I broke out, armies on both sides were armed with machine guns. This war would be fought among industrialized nations that mobilized their populaces to fight total war; a hint of this new warfare was glimpsed in the U.S. Civil War, which demonstrated a scale and bloodiness not seen before. In World War I, the introduction of new weapons, such as poison gas and the machine gun, made it one of unprecedented carnage. Millions would perish. Many thought the war would last only a few months, but the sheer potential of the combatants in materiel and industrial capacity dictated a prolonged quagmire of trench warfare. The British began the war thinking that 100,000 men would suffice; by December 1915 that number had reached 3.5 million. In this war of attrition, a premium would be placed on weapons that annihilated the enemy as quickly and efficiently as possible. Thus, according to historian John Ellis, author of *The Social History of the Machine Gun,* "the increased reliance on the machine gun that was a feature of the 1914–18 War was an inevitable consequence of the necessity to wear one's enemy down as cheaply and completely as was technically possible."[2] By the end, each side was producing machine guns in huge quantities.

And though the participants possessed and deployed machine guns, huge industrial production was not the rule when war began. It is said that one British commander, when asked by his subordinates where to place the newly issued machine guns, replied, "take the damned things to a flank and hide 'em."[3] It took some time for armies to work out the best tactics. The British, like the French, initially mounted them on large wheeled carriages and used them much like light field guns, deployed in the open to fire at massed formations of enemy troops. This proved disastrous when skilled riflemen were able to bring the machine-gun crews under effective fire, and casualties among these crews were high.

Great Britain

The British, like most armies, initially armed infantry battalions with two machine guns each. This was adequate for a war of movement, which most theorists assumed would occur. This is primarily because the British, like the other armies, were obsessed with past traditions and outmoded concepts of warfare. The lessons of industrialized total warfare seen in the U.S. Civil War, as well as the impact of the machine gun during the Russo-Japanese War, went largely unheeded in Great Britain. British officers continued to see the battlefield as a place where individual heroism prevailed, not realizing total war meant that numbers, not individuals' heroism, made all the difference on modern battlefields. Ellis notes that such reactions "were rooted in the traditions of an anachronistic officer corps whose conceptions of combat still centered around the notion of hand-to-hand combat and individual heroism."[4] Thus, in the British Army there was a prejudice against technology and, by extension, the machine gun. Because of that prejudice and the soon-to-be obsolete ideas about warfare, there was no reappraisal of tactical thinking because of the presence of the machine gun on the battlefield.

Additionally, there were relatively few machine guns available at the beginning. The British possessed 200–300 guns, with the expeditionary force to France taking 108 guns to serve six divisions (some 70,000 men).[5] These were attached in sections to individual battalions. The British would not form the Machine Gun Corps until October 1915. As one British officer observed, "It took our General Staff many months of terrible loss to realize the worth of the machine gun."[6]

Germany

The Germans were farther-thinking than the Western Allies, recognizing the potential of the machine gun. By August 1914, the Germans had 8,000–12,000 machine guns; by the end they had more than 100,000. Thus the Germans were the first to deploy large numbers of machine guns; they were also the first to strip them from reserve forces to bolster front-line units. They formed their machine-gun crews into companies, which concentrated the weapons and greatly increased their impact on the battlefield. The British initially assigned their machine guns to the infantry battalions, and they were

thus less flexible in their employment than the German approach, which permitted them to put their machine guns where they were most needed. Additionally, the Germans mounted their guns on tripods or small, hand-towed wheeled carriages. Using the machine guns to support infantry battalions, they fired them from protected positions and massed their fires. The impact of this approach first became apparent in September 1914, when the Germans reached the Aisne River and turned to face pursuing British and French forces. Up to that point, the machine gun's utility was limited due to the fluid nature of combat, but the Germans dug in and set up an extensive line of machine-gun nests. John Keegan, author of *The Face of Battle,* suggests that the machine gun was "not unlike in some respects to a precision lathe," which, once set up, "operated virtually automatically, shooting down anything in its path with a reliability far exceeding that of a rifleman."[7] The Western Allies, unable to penetrate this defensive line, had no choice except to dig in as well. Historian John Bourne best describes the situation that soon developed: "Dense belts of barbed wire, concrete pillboxes, intersecting arcs of machine-gun fire, and accumulating masses of quick-firing field and heavy artillery rendered manoevure virtually impossible."[8] The war of movement was over, and the deadly dance of firepower ensued: the two lines of trenches on the Western Front would remain at almost the exact same spot for the next four years.

A RACE BETWEEN TACTICS AND TECHNOLOGY

Yet the Western Allies remained virtually blind to the impact of the machine gun; with the turn to trench warfare, the advantage had shifted to the defensive, and the machine gun ensured that fact. As one historian put it: "It was as simple as this: three men and a machine gun can stop a battalion of heroes."[9] Allied commanders were slow to realize this fact. Their outdated ideas about warfare extracted a massive toll in soldiers' blood.

Despite the fact that the machine gun made defense the stronger form of combat, commanders in the Western armies continued to stress the offensive and the bayonet—much to the detriment of their troops, who would be forced to launch repeated attacks into massed fires of enemy machine guns and artillery. To these commanders, victory would always go to the side with the best-trained,

most-disciplined army, commanded by generals of "iron resolution," prepared to maintain the offensive in the face of huge losses.[10]

One of the first examples of this dynamic took place at Neuve Chapelle in March 1915, when the British launched an offensive against the entrenched Germans. After a preliminary artillery barrage, intended to knock out German front-line defenses, the Tommies went over the top, only to face withering fire from machine guns. At one point during the attack, two machine guns virtually wiped out two British battalions. This happened time and again, up and down the lines.

Still, British leaders took few lessons from this action. In September 1915, they again tried a frontal assault at Loos, with the same result. In little more than an hour, German Maxims reduced a 12-battalion British assault to less than a fifth of its initial strength of about 10,000 men. Still, no one questioned British tactics; it is hard to believe that senior leaders failed to recognize that the machine gun had transformed the range, accuracy, and lethality of modern military firepower. They repeatedly sent soldiers against entrenched troops armed with hundreds of machine guns supported by artillery.

This insanity reached new heights in July 1916, when the British commander, General Sir Douglas Haig, ordered a new offensive along the Somme River, one of the strongest points in the German line. As British troops made extensive preparations for the designed general offensive, the Germans made preparations on their side. Anticipating that the Tommies would precede the attack with a massed artillery barrage, they deepened the trench system and limited the number of infantrymen in the front lines, where they were inviting targets for enemy artillery. Instead they sited machine guns in deep dugouts located to the rear of the main trenches and practiced bringing them up and into action quickly, thus largely negating the effects of the preliminary artillery barrage.

On 1 July, the British battalions went over the top. The German machine guns had survived the artillery and wrought havoc. A German gunner later reported, "When we started firing we just had to load and reload. They went down in the hundreds. You didn't have to aim, we just fired into them."[11] Two British battalions, the 7th Green Howards and the 10th West Yorkshires, which had been ordered to attack the German strongpoint at Fricourt, were practically wiped out in less than 3 minutes by a single machine gun. This was by no means an exceptional occurrence. Historian A. H. Farrar-Hockley described the assault of the Canadian 1st Newfoundland Regiment: "The Newfoundland officers and men would not halt;

they had orders to advance into the enemy line: they advanced. 710 men fell. Some minutes later, three companies of the Essex emerged on their own front to fall, as gallantly but as forlornly just inside the enemy line."[12] A similar fate befell almost every one of the 129 battalions that went over the top on that day. Fifty percent became casualties, including 75 percent of officers; 19,240 British soldiers were killed on the first day, and overall casualties for the initial 24 hours were 54,470. For the entire Battle of the Somme, British casualties totaled more than 250,000 men, with very little territory gained as a result.

The Race to Arm

The belligerents realized that with the machine gun dominating the battlefield, they would need many more such weapons. When war started, the general allocation of machine guns on the Allied side was some 24 guns per division of 12 battalions. By the end, the divisions had been pared to nine battalions, but the number of machine guns had increased to 160.

This demanded production to match the need. The primary machine guns at first were the Maxim, the Vickers, and the Hotchkiss guns of prewar days, but as war progressed there was a demand for lighter, more portable guns. Tripod-mounted, water-cooled machine guns were simply too heavy and could not be carried easily by the infantry in their assaults across no-man's land. Part of the answer was to look for designs that were lighter, less expensive to manufacture, and easier to make than the Maxim derivatives.

On the Allied side, the choices for a lighter, more portable machine gun came down to the Madsen, the Hotchkiss, and the Lewis. The Danish Madsen was considered too complex and difficult to put into action. The Hotchkiss was an improved model, known as the Light Hotchkiss, which went into production in vast quantities in Britain and France. It became the primary armament of cavalry units.

AIR POWER

While the machine gun played a seminal role in the bloodletting on the ground, it was also applied to combat in the sky.

The Lewis

It had been a hard sell at first, but the American Isaac Lewis was instrumental in applying the weapon to aerial combat. In June 1912, Lewis had persuaded the commanding officer of the U.S. Army Experimental Flying Station at College Park, Maryland, to take up a Lewis gun in a Wright biplane and fire it at a ground target. Several hits were achieved, but the Army was not impressed. One of the Army observers reportedly asked, "Who would ever want to fire a machine gun from an airplane?"[13]

Lewis was not deterred. He tried to persuade the Belgians to try the same experiment later in 1912, and the British in 1913. In both cases, he did not gain any takers. In 1914, however, two British aviators took up a Lewis gun in their BE.2C biplane and took a few shots at a German Albatross at 5,000 feet. They reported what they had done, but it was quickly pointed out to them that this was a "dashed unsporting attitude and should not be repeated. After all, the Germans might start shooting back, and then where we will all be?"[14]

Of course, the Germans did start shooting back, and aerial combat soon became the norm, giving rise to the pursuit aircraft, which could not have existed without the machine gun. For the Allied aircraft, the Lewis gun proved to be ideal for this role. In the early aircraft, the gun was used for the observer to protect the pilot. The gun was mounted on a swivel on a post in front of the observer. He could then swing the gun around to engage targets as necessary. He could also store extra ammunition drums in the cockpit. It was soon determined that a 47-round drum did not last long, so a 97-round model was produced. When single-seat aircraft were sent up, the need for armament continued, but there was no observer to operate the machine gun. The initial solution was to fit the gun on top of the upper wing of the biplane so the pilot could fire the gun himself from the cockpit. But a French aviator, Roland Garros, wanted to place the weapon on top of the engine cowling so he could aim it better. The problem with that idea was the propeller spinning in front. How was one to shoot bullets in this way without destroying the propeller in the process? Garros simply attached steel plates to the propeller blades where each passed in front of the gun. He then took to the air, pointed himself at a German airplane, and pressed the trigger. Some of the bullets hit the steel plates and ricocheted off, but most passed between the spinning blades. He hit the German plane and shot it down.

Fokker

The Germans were mystified about what had happened until Garros was shot down by flak and captured in April 1915. They soon learned the secret of his steel plates and set about improving on the idea. Anthony Fokker, the Germans' principal aircraft designer, developed a mechanical synchronizer that permitted the gun to fire only when the propeller arc was clear. The Germans had already begun an effort in 1909 to develop a machine gun suitable for carrying in aircraft. The result was the 1911 Parabellum machine gun. This was derived from the Maxim but was much lighter, primarily because the designer, Karl Heinemann of the Deutsche Waffen und Munitionsfabrik of Berlin, did away with the heavy water jacket that was critical to the Maxim gun and replaced it with a perforated jacket, which allowed air to flow past the barrel for cooling purposes. The Germans applied Fokker's synchronizer to a pair of twin Parabellum machine guns mounted just behind the engine of single-seat aircraft. For the moment the Germans gained control of the skies over the Western Front. But the Allies responded with their own synchronizer. It was now common practice for aviators to fire between the spinning blades of propellers.

THE UNITED STATES ENTERS THE WAR

While opposing aviators battled above the Western Front, the ground forces below clamored for more machine guns. When the United States entered the war in April 1917, and the U.S. Army began to rapidly expand, the demand for every kind of weapon far outstripped the available supply. The United States had not been particularly well-armed with machine guns to begin with; initially it obtained most of its machine guns from European allies. The Army service weapon prior to the war was the Maxim Model 1904, of which the Army owned 282 in 1914. The Benet-Mercié Machine Rifle, a light machine gun of the Hotchkiss design, was also in service, but it was not considered to be a very good weapon. As the war raged across the Atlantic, the U.S. Army adopted the British Vickers gun in 1915, converting it to fire the caliber .30 cartridge. Colt manufactured more than 3,000 of these for Army use in Europe. An additional 6,000 were secured from Vickers in Britain.

As the United States neared entering the war in Europe, it became clear U.S. forces needed a light machine gun. They turned to the French, who had developed an earlier model designed by Captain Louis Chauchat and Master Armorer Charles Sutter at the Puteaux Arsenal. It first went into production at the Gladiator army plant in 1915. Known first as the Gladiator, it was designated by the French Army as the CSRG (based on the initials of the two designers and Paul Ribeyrolles, the plant's production manager, and the first letter of Gladiator), but the weapon became commonly known as the Chauchat. It was rushed into production in 1915, but like many things developed by committee, the Chauchat had serious shortcomings. It soon earned the reputation as the most hated gun ever issued to soldiers.[15] Although very light at less than 10 kilograms, the weapon was poorly made; it was constructed from stamped or turned parts so that it could be made in any engineering shop. Without true machining, much hand-fitting had to be done on each unit to make it operate, and interchangeability of parts was impossible. In addition, as many as four men were required to transport its ammunition in drums. The gun gave rise to a series of fraud and graft charges directed toward French government officials and the manufacturers, mainly due to the poor materials used in manufacture. In addition to shoddy materials, the design was highly inefficient, and the gun normally jammed after two or three bursts. Nevertheless, as U.S. forces prepared to enter the war, they purchased 12,800 Chauchat guns from the French. The Chauchat, notoriously unreliable in the field, proved a disaster for French and U.S. forces. The U.S. Marines soon ditched their Chauchats and adopted the Lewis, but the U.S. Army continued to use the Chauchat along with the Lewis.

Production Powers Up

While the U.S. troops entered battle with foreign weapons, the arms industry in the United States tooled up to produce indigenous designs. In 1901, John Browning, who had invented the Colt Model 1895 Machine Gun (the Potato Digger), had begun working on a design for a new recoil-operated machine gun. However, with no threat looming then on the U.S. horizon, Browning could not interest the U.S. Army in his design. He put it aside until reintroducing it in 1910, yet he still could not find any interest in his weapon. By late 1916, it was becoming obvious that the United States was likely going to war in Europe, so Browning again brought out his design.

The Browning M1917 Machine Gun is a superb weapon. It, like the Maxim and Vickers guns, is water-cooled, belt-fed, and derives its power from the recoil force. However, its design is extremely different from the British-manufactured guns. The major feature is the addition of an accelerator that gives the bolt a boost backward with more force and makes the action more efficient. The Browning firing mechanism is relatively simple and easy to strip and reassemble, making it easier to maintain in the field. It is also tough and reliable because there fewer parts to break.

Browning demonstrated his machine gun to the U.S. Army in February 1917 and submitted it for trials in May. The gun performed well, firing 40,000 rounds without a single component breaking and only two stoppages, both of which were due to the ammunition. The Army was impressed with Browning's weapon, and it entered production as the Browning M1917 Machine Gun; more than 70,000 Brownings were manufactured between 1917 and 1919 by Colt, Remington, and Westinghouse. Unfortunately, as George M. Chinn points out in *The Machine Gun,* the "clean lines and simplicity of construction of the Browning automatic machine guns ... arrived too late to offer more than a token demonstration against an already defeated enemy."[16] Nevertheless, the well-made weapon would have a long life and remain in service, in a variety of forms and calibers, for many years.

The BAR

Browning also started developing a light machine gun. He envisaged what would be essentially a heavy, magazine-fed automatic rifle that could be carried and used by one person. The result was the Browning Automatic Rifle (BAR) M1918. (Despite its name, the weapon began production in 1917; Browning named it to distinguish it from the M1917 machine gun.)

The BAR was a gas-operated, magazine-fed caliber .30 rifle that could fire automatically and semiautomatically. In 1917, the U.S. Army was heavily influenced by the French Army and its doctrines. The BAR worked very well with the tactics that the French employed on the Western Front, particularly the idea of *walking fire,* in which the troops clambered out of trenches and advanced toward the enemy while carrying automatic weapons at the hip. The troops fired constantly as they advanced, trying to make sure that the en-

emy stayed down and did not return fire. This was fine in theory, but there were problems. First, the soldiers needed to carry enough ammunition to sustain the attack. Second, producing enough weapons and ammunition was itself difficult. In the role of providing walking fire, the BAR performed well.

By the end of the war, more than 52,000 BARs had been manufactured; half went to the American Expeditionary Force (AEF). All U.S. divisions sailing for France after July 1918 had a full complement of Browning machine guns and BARs. The BAR became the base of fire for the infantry section, an automatic weapon that could move along with the section and provide direct fire support, much like the role of the much heavier, less mobile machine guns. The BAR, which most armies (other than the U.S. Army) would consider to be a light machine gun, was an excellent weapon that met an important need.

The BAR and the M1917 were unique because they were developed, completed, produced, and fielded inside the space of the war years. Britain, France, Germany, and Russia fought the war with guns developed during the prewar years (with occasional modifications to some designs). Browning's weapons were exceptionally well-made and would remain in service in many armies, including that of the United States, into the 1950s.

By the end of the war in 1917, then, knowledge about machine guns and their role in relation to artillery weapons, automatic rifles, and other arms had been perfected. The machine gun was firmly established as an infantry weapon, firing from protected positions and mounted on tripods or carriages. Heavy machine guns, like the Vickers and other Maxim variations, had proved their worth in defensive roles in battle after battle, but they were still static and defensive weapons, difficult for crews to move. Therefore, lighter machine guns (the British Lewis, the French Chauchat, several German weapons, and the U.S.-made BAR M1918) were developed to meet the need for mobility. Most of these light weapons were gas-operated and air-cooled, and fired magazines rather than belts of ammunition, because detachable magazines were more convenient and more easily transported.

Whether heavy or light, the machine gun had dominated World War I, sounding the tragic tone and demonstrating that warfare had changed fundamentally. It is estimated that the British and French each lost more than 1 million soldiers, the Germans more than 2 million. The role of the machine gun in producing this devastation

is clear. One historian observed of the Maxim machine gun: "Although exact numbers will never be known, Maxim's invention has been estimated to have claimed more lives than any other single weapon devised by man, a distinguished if dark legacy."[17] Great Britain's Lloyd George said that more than 80 percent of World War I casualties were caused by machine guns.[18] This is debatable, as other figures suggest artillery. Nevertheless, Maxim and his fellow inventors had developed weapons that ushered in a new age of warfare marked by levels of bloodshed and devastation never before seen. According to military historian Trevor Dupuy, "The machine gun proved to be one of the most significant of all advances in lethality since the introduction of gunpowder."[19] Some had mistakenly hoped that the machine gun would make war *so* horrible that conflict would be avoided; some even hoped that World War I was the war to end all wars. However, the new weapons merely transformed war, making the battlefield even more deadly in the process. Perhaps Peter Chamberlain and Tony Gander put it best in *Fact File on the Machine Gun*:

> Of all the hideous "engines of war" produced in the twentieth century, none has extracted more dreadful toll of human life than the machine gun.... It reached the peak of its destructive powers during World War One, when the military and political course of the world for the next three decades was dictated by the dominance of the machine gun over the battlefield.[20]

CONCLUSION

As Anthony Smith suggests in *Machine Gun,* the new weapon produced a stalemate on the Western Front, which had several significant impacts on the face of battle. Bogged down in that stalemate, military planners were forced to turn to new ideas, like the tank and airplane, to break the impasse. The machine gun also killed off most any role for horses and turned the old styles of warfare upside down. In doing so, the machine gun won an important place in the armies of the world. It would never again hold sway as it had during World War I. It would, however, play a major role in the next world war and all other wars to come. The machine gun's day, as historian Anthony Smith has noted, had certainly not receded with the Treaty of Versailles.[21]

NOTES

1. Ian V. Hogg, *Guns and How They Work* (New York: Everest House, 1979), p. 110.

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3. G. S. Hutchison, *Machine Guns: Their History and Tactical Employment* (London: Macmillan, 1938), p. 136.

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5. Anthony Smith, *Machine Gun: The Story of the Men and the Weapon That Changed the Face of War* (New York: St. Martin's, 2002), p. 195.

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15. Peter Chamberlain and Terry Gander, *World War 2 Fact Files—Machine Guns* (New York: Arco, 1974), p. 14; Ian V. Hogg, Guns and How They Work (New York: Everest House, 1979), p. 114.

16. Quoted in George M. Chinn, *The Machine Gun: History, Evolution, and Development of Manual, Automatic, and Airborne Repeating Weapons* (Washington, DC: U.S. Department of the Navy, 1951), vol. XXXX, p. 179.

17. Jonathan W. Jordan, "Hiram Maxim's Machine Gun Probably Claimed More Lives Than Any Other Weapon Ever Made," *Military History* (October 2002): p. 20.

18. Ellis, *The Social History of the Machine Gun*, p. 142.

19. Trevor N. Dupuy, *The Evolution of Weapons and Warfare* (New York: Bobbs-Merrill, 1980), p. 293.

20. Chamberlain and Gander, *World War 2 Fact Files*, p. 1.

21. Smith, *Machine Guns*, p. 280.

CHAPTER 5

The Development of the Submachine Gun

Although machine guns like the Maxim and the Browning M1917 dominated the battlefields of World War I, innovations during the latter phase of the war led to the development of submachine guns (known as machine carbines to the British and machine pistols to Germans). This new class grew out of the need for an automatic weapon that could be used during the close-in combat required to clear enemy defensive positions and trench lines. The new infantry assault tactics developed by Germany during the latter part of World War I called for individual firepower at close range by infantrymen attacking enemy trench works, a task for which the bolt-action rifle and the heavy machine gun were ill-suited. And though the submachine gun debuted during the closing stages of the war, the Versailles Treaty of 1919 would relegate it to the backwaters of arms development—until, that is, the outbreak of World War II. As arms historian Ian V. Hogg wrote, the submachine gun suffered "a tedious and painful adolescence."[1]

CHARACTERISTICS

Submachine guns (any small, handheld, fully automatic firearm chambered for pistol ammunition) are characterized by low weight and short range and may be fired from the shoulder or hip (as op-

posed to the existing machine guns of the era, which were heavy, had good stopping power at long ranges, and were typically mounted on a tripod or carriage). It has advantages, not the least of which is the high volume of mobile firepower that it provides infantry. However, the weapon has limitations. The ammunition used in submachine guns was derived from existing pistol rounds, which meant that range was restricted to no more than 100 meters, the stopping power dissipating beyond that. Thus it was not advisable to issue the weapon in isolation; rather it had to be used as a supplement to existing rifles and light machine guns deployed at the squad level and for special purposes. This was the tack that the United States and Britain would take once they developed working submachine guns. However, the Soviet Red Army and then the German Army under the Nazis ignored such limitations and equipped whole squads with nothing more than submachine guns. Before it got to that point, however, the submachine gun had to be perfected as a viable weapon system.

History

Weapons expert and author Roger Ford suggests that the history of the submachine gun can be divided into two parts.[2] The first phase involved weapons that met the precision standards maintained by weapons makers during the nineteenth century. The second phase began when World War II broke out and mass production methods took over.

The first submachine guns were manufactured by traditional methods: steel forging, machining to close specifications, and hand-finishing. They took a long time to produce and were expensive. One of the first effective submachine guns from this era was developed in Germany by Hugo Schmeisser, chief designer for the Theodor Bergmann company of Berlin, in 1916. This weapon, which Schmeisser called the Musquete, was a simple blowback gun with a short barrel surrounded by a perforated jacket and wooden stock. The weapon, also known as the Kugelspritz (Bullet Squirter), was chambered for the 9mm Parabellum pistol round. Bergmann made a small number of these weapons and submitted them to the German Army for its opinion. The German high command thought that the weapon was reasonably effective, but at that time they could not see how it did anything that other weapons could not already do, so there was no need to complicate the supply line.

Hutier Tactics

In September 1917, new tactics developed by German General Oscar von Hutier were tried for the first time, resulting in the capture of Riga, a defensive position that had defied German attacks for more than three years, in less than 24 hours. While France and Britain sought to overcome the stalemate on the Western Front with new machines like the tank, Hutier and his fellow Germans attempted to do so by devising new tactical concepts. The so-called Hutier tactics involved special Stosstruppen (Storm Troops), who achieved surprise by attacking after a brief, violent artillery bombardment meant to saturate and isolate specific points in the opponents' defensive line. The specially trained infantry troops moved rapidly through the enemy lines, bypassing enemy strongpoints for the follow-on forces of regular infantrymen. The assault troops, supported by light artillery, mortars, and fire from heavy machine guns emplaced far forward, flowed into weak points, with the objective of punching narrow corridors deep to the rear rather than trying to advance along a whole front. Such attacks were designed to isolate front-line units of the enemy, disrupt communications, and allow the attackers to reach the enemy's rear areas before reinforcements could arrive.

The key to the success of Hutier tactics, which figured prominently in the German offensives of 1918, was mobile firepower. Hutier's troops had used the Madsen light machine guns during their mobile attacks. Later, MG08/15s and captured Lewis guns would be used by German troops. However, the new tactics required a different kind of weapon that would provide storm troopers enough firepower but still be light enough to be carried in the attack. The requirement was individual firepower employed at short range while on the move.

German Machine Pistols and Prototypes

The time had come for the Bergmann Musquete. Bergmann and Schmeisser revived their ideas and provided just the weapon that was needed—"a machine gun in miniature."[3] The design was tried, approved, and went into production as the Maschinen Pistole (Machine Pistol) 18 (MP18), a revolutionary landmark in the development of automatic weapons. The MP18 was made using the traditional methods of the day; the receiver and moving parts were forged

roughly to shape and size, then machined out of the solid metal. Its firing mechanism was simple, with a minimum of moving parts; it employed the unlocked breech/direct blowback system of actuation, in which the spent cartridge case, blown backward out of the chamber by the gases generated by firing a round, forced the bolt back against a spring and tripped the mechanism that ejected the case from the gun. The spring then forced the bolt forward as a fresh cartridge was fed into the chamber. If the trigger was kept depressed, the new round would be fired automatically, and the cycle would continue until the trigger was released or the ammunition exhausted. This had already been used in self-loading pistols of the era. The MP18 was fed from the right from a detachable 32-round clockwork drum (known as a snail drum for its distinctive shape).

Using lower-powered 9mm Parabellum pistol ammunition, the MP18 overcame the major disadvantage of blowback systems: poor ejection of spent cartridges. The weight of the bolt was kept low, which enabled the weapon to achieve a high cyclic rate of fire. The barrel was made short to facilitate close-quarters fighting. Although these characteristics added much to the effectiveness of the weapon, there were drawbacks. The high rate of fire, about 400 rounds per minute, meant that it would fire rapidly until the gunner released the trigger; thus it used up a lot of ammunition. In addition, the weapon tended to climb upward during automatic fire and was difficult to aim on target. The short barrel also translated into inaccuracy.

Despite the shortcomings, the MP18, which weighed just over 11 pounds, was an effective weapon and fit the bill for the new Hutier tactics. It gave individual infantrymen vast enhanced firepower in a lightweight weapon that was reliable and easy to handle. Although the Germans would ultimately succumb, the machine pistols played a major role in the early successes of the 1918 German offensives. The MP18 enjoyed a long service life; more than 30,000 were produced at Bergmann's Suhl factory before the war ended. After the war, the gun was used by the Weimar Republic's police forces in an increasingly futile attempt to maintain order within postwar Germany. Others were exported to police and military forces elsewhere.

The MP18 helped define a new category of weapons sharing common characteristics: light weight, short range, automatic firing, pistol ammunition, blowback operation, and firing capable from the shoulder or hip. Sometime after World War I an American, John Thompson, named these weapons submachine guns.

After World War I, Schmeisser went in with another gun maker,

C. G. Haenel of Suhl, and continued to work on his designs. The result was the MP28, a close derivative of the original MP18. This model had a selective-fire switch and was capable of firing single shots (semiauto, i.e., one trigger pull equals one shot fired). It was manufactured in different calibers and is fed by a 20-round or 32-round magazine. Schmeisser transferred production of the MP28 to the Pieper factory in Herstal, where it was produced for the Belgian Army and exported to South America, Asia, and other European countries. It was also made under license in Spain. The design of the MP28 was so sound that it was copied by other armies. The basic principles of the MP28 (and its predecessor, the MP18) were used in virtually every successful submachine gun for the next 30 years.

Other German manufacturers recognized the worth of the submachine gun. One of these, Erfurter Maschninwerk B. Geipel (Erma-Werke), produced the MPE, which would provide the basis for the best-known German submachine guns, the MP38 and MP40. Berthold Giepel and Heinrich Vollmer of Erma-Werke developed a self-contained unit in which the bolt, firing pin, and return spring were enclosed in a telescoping tube. This unique design was incorporated into a simple blowback SMG with a wooden stock and side-mounted magazine. The MPE, chambered for the 9mm Parabellum cartridge, was very popular with police forces. It was made under license in Spain. It also saw extensive use during the 1930s in Switzerland, the Spanish Civil War, and the Chaco Wars between Paraguay and Bolivia. It was adopted in 1935 by the Yugoslavian army. However, Giepel and Vollmer could not interest the German Army, because German arms experts saw no practical use for the new weapon.

PERFECTING THE SUBMACHINE GUN

This changed in 1936 when the German Army, developing something new in the form of an armored division, needed a small, lightweight weapon that could be used by soldiers riding in tanks and troop carriers, where long conventional rifles were inconvenient. A call went out to Giepel and Vollmer. The designers had been busy and were ready. They had already made design modifications and improvements to the MPE; this resulted in the MP38, considered by many to be the first modern submachine gun.[4] The MP38, which went into production in 1938, was an all-metal, folding-butt

machine pistol with a vertical underset magazine. The gun operated using simple blowback principles, although it was the first submachine gun to have a safety device to catch the bolt if it moved inadvertently. This became necessary because earlier models sometimes fired accidentally if the weapon was dropped on a hard surface.

Originally developed for tank crews and security personnel, the MP38 would later be issued to infantry units and security troops. Extremely reliable and effective, the MP38 served as the prototype for the MP40, the first mass-produced submachine gun. When World War II began, there was an immediate increased need for the MP38, but it was too expensive and time-consuming to produce given wartime pressures. Time and materials were short, and the German Army, the Wehrmacht, needed a bullet hose, not a precision weapon. In response to that need, the MP38 was redesigned, substituting sheet-metal pressings for the machined parts of the MP38. In addition, spot welding and other techniques were used to cut costs per unit and to speed manufacture, making it suitable for mass production; the resulting model was designated the MP40. The new weapon, which had a plastic fore grip, was one of the first firearms in which plastic was used as a substitute for wood and metal. It was also the first submachine gun to be designed specifically for fast, economical manufacture. More than 1 million MP40s would be produced by the end of the war, and it would become one of the best-known German weapons of World War II. Its folding stock made it compact and easy to carry, and it was extremely reliable in combat. The Allied soldiers routinely referred to the MP40 as the Schmeisser, despite the fact that Hugo Schmeisser, designer of the Bergmann MP18 SMG in 1918, was not involved in the design of either the MP38 or the MP40 in any way.

Clandestine German Rearmament

Another excellent German submachine gun was developed during the 1920s. However, because German arms manufacturers could not operate openly under Versailles, many clandestinely began using factories located in Holland, Denmark, Switzerland, and even Russia. One of these German manufacturers, Rheinmetall of Dusseldorf, established a subsidiary in Switzerland. Called Waffenfabrik Solothurn, the factory developed the Steyr-Solothurn S1-100, which would eventually be manufactured in Austria in great numbers. It was a derivative of the MP18 and MP28 and saw wide serv-

ice from 1930 through 1945. It was made in a variety of calibers and was also offered as a light machine gun, with a longer, heavier barrel and a bipod.

Italy

Because of the work of designers like Giepel, Vollmer, and others, Germany would be the only nation to enter World War II already producing a simple machine pistol for troops. However, that did not mean that the weapon was totally neglected by other nations during the interwar years. The Italians had developed a submachine gun during World War I. The Italian Army had wanted a specialized weapon for mountain troops. In 1915, Revelli of the Villar Perosa engineering company designed the Mitragliatrice Leggera Villar Perosa M15. This was a strange weapon that was actually two guns in one, with the twin barrels and actions mounted side-by-side, each with a vertical box magazine and sharing a single trigger. It had an extremely high rate of fire, but the 25-round magazine limited the output. It was chambered for the 9mm pistol cartridge, but that cartridge proved inadequate for a light infantry weapon. The M15 was used as a squad light machine gun rather than as a submachine gun (as the MP18 was utilized).

From the basic M15 design evolved two other weapons, the Moschetto Automatico OVP and the Beretta Modello 1918, both of which were more conventional, single-barrel submachine guns. Both were capable of semiautomatic and automatic fire.

The Modello 1918 provided the basis for two other machine pistols that Beretta produced in the years before World War II. The Modello 18/30, an update of the Modello 1918, was rechambered for the more powerful 9mm Parabellum round, greatly increasing firepower. Another variant was the Modello 38A, which was manufactured to high standards. However, the Italian economy demanded that costs be reduced, and the weapon was subsequently revamped to make it easier and cheaper to manufacture.

THE TOMMY GUN

Toward the end of World War I, while Schmeisser and others worked on European designs, across the Atlantic Ocean a U.S.

Army retired officer developed what became one of the most famous submachine guns in history. John Taliaferro Thompson was born in 1860 and graduated from West Point with the class of 1882. Upon commissioning, he entered the artillery but transferred to the Ordnance Department in 1890. He distinguished himself during the Spanish-American War when he directed the supply of munitions at a time of near-chaos in the ordnance and quartermaster units.

Development

After the war, Thompson was involved in testing and adopting the Springfield M1903 rifle, but he became famous for tests he conducted that resulted in adoption of the caliber .45 ACP round as the official U.S. Army handgun cartridge. Various calibers were tested on cadavers. Later, in the slaughterhouses of Chicago, Thompson conducted tests on live beef cattle to determine the best cartridge. From these tests, he determined that the caliber .45 was the only acceptable cartridge for a handgun; this played a major role in the adoption of the Colt M1911 automatic pistol by the U.S. Army. Thompson retired from the service in November 1914 and joined Remington Arms Company as chief engineer.

Thompson always maintained an intense interest in developing a certain automatic weapon, an intermediate in the ballistic class between the pistol and the rifle that could be used to help break the stalemate of trench warfare in Europe. To do so, Thompson had to overcome several problems. He rejected gas operation as being too complicated for a shoulder-fired arm. Recoil operation, he believed, would result in a weapon that would weigh too much, and blowback operation was not suitable for a powerful military cartridge. These obstacles nearly exhausted the means of operation available at that time.

Thompson learned that Commander John Blish, U.S. Navy (retired), had patented a delayed-blowback breech system in 1915. This system employed a sloping metal wedge that interlocked the breech block with the body. Under high pressure, as when the cartridge fired, the angle of the slope was such that the mating faces jammed solid. As pressure dropped, the faces were able to slip across each other, the wedge moved up due to the slope, and the breech unlocked.

Auto-Ordnance Company

Thompson saw the applicability of Blish's patent, so he offered him shares in a company Thompson was forming in exchange for the patent. Blish accepted, and the Auto-Ordnance Company was founded in 1916 with the financial backing of tobacco tycoon Thomas Fortune Ryan. Thompson hired a design engineer, Theodore H. Eickhoff, to work on his ideas. He also hired George E. Goll, an unemployed railroad fireman, as his chauffeur. Thompson quickly recognized Goll's intelligence and mechanical aptitude, offering him a job as Eickhoff's assistant. Under Thompson's direction, these two men would become the principle designers of Thompson's SMG. Later on, Oscar V. Payne joined Auto-Ordnance; he would be responsible for many of the design innovations that made the gun a success, including the self-oiling system and the high-capacity rotary-drum magazine. Thompson was recalled to active duty in Washington for World War I in 1917, and work proceeded under his design team while he monitored and guided their work from afar.[5]

At the start, Auto-Ordnance was a shoestring operation without offices or machinery. Consequently, all prototypes and machine work had to be contracted out. Most of the work was done with W. R. Warner and Ambrose Swasey, who Thompson knew from their Cleveland-based machine-tool business (it had contact with the Army Ordnance Department while he served). Warner and Swasey provided Thompson with several of their best engineers and machinists and provided a testing room in the basement of the Cleveland plant.

The designers quickly learned that a rifle cartridge would not work; with high-powered rifle ammunition, the weapon would fire a few rounds and then jam. Additionally, under the high pressure of the rifle ammunition, abrasion would quickly wear out the lock. Finally—and worst of all—cartridge cases would not extract reliably unless they were lubricated before being chambered. These shortcomings were serious, particularly if Thompson hoped to sell the military on his firearm, which would be expected to function under extreme adverse conditions. After a series of tests, the designers determined that the caliber .45 pistol cartridge would work reliably in concert with the Blish lock.

Although the designers were reluctant to tell Thompson that the rifle cartridges would not work (he still harbored ideas about an au-

tomatic rifle), Thompson was pleased nonetheless with his team's work, saying, "Very well. We shall put aside the rifle for now and instead build a little machine gun. A one-man, hand held machine gun. A trench broom!"[6] This was late 1917, and Thompson was alluding to the trench warfare on European battlefields. In fact, Thompson had already recognized the necessity for such a weapon. He, like many observers, had seen that nineteenth-century tactics and twentieth-century technology did not mix. The traditional charge by cavalry on horse did not work well against the modern machine gun, as it provided defenders a great advantage. However, these same guns were too large and too heavy to be used while on the offensive. Thompson saw a need for a weapon with good firepower that could be used in the hit-and-run tactics that he believed were necessary to break the stalemate and win the war. He envisioned troops carrying compact machine guns rushing from trench to trench, sweeping the enemy with a hail of bullets, firing from the hip while rushing forward. The use of the Bergmann MP18 by German troops late in the war only served to confirm Thompson's ideas about the need for an intermediate weapon of this type. So under his direction, Eickhoff and the other designers went to work to produce just such a weapon.

Thompson's new gun used a delayed-blowback action fed from a characteristic drum magazine (sporting an outline that became well-known), a finned barrel, two pistol grips, and a short butt. It was capable of firing 450–600 rounds per minute. Because it used a pistol cartridge, it was not very accurate beyond fifty yards; it was a close-quarters weapon.

By the summer of 1918, all of the major design problems had been resolved. The result was called the Annihilator I, capable of emptying a 20-round magazine in less than 1 second. Work continued until the fall of 1918, when final prototypes were completed. The first shipment of the guns designed for Europe arrived at the docks in New York City on 11 November 1919—the day the war ended. Thompson now faced a huge problem: What to do with the trench broom now that the trenches no longer needed to be swept?

The Mean Streets

With the signing of the Armistice, Thompson's major intended customer, the U.S. government, facing postwar budget restrictions, lost interest. With no trenches left to sweep, Thompson shifted gears

and began to promote the new weapon as a police gun. Since there was no law at the time preventing the sale of a submachine gun to a citizen, Thompson also opened sales to the public. Unfortunately, this attracted customers whom Thompson neither anticipated nor wanted. As William W. Helmer, historian of the Thompson, put it: "Lack of police and military interest made it by default a civilian weapon. And so it came to pass that the Thompson—manufactured in peacetime, sold on the commercial market—was, in a sense, a machine gun for the home."[7]

In 1919, Thompson gave Auto-Ordnance the task of modifying the new gun for nonmilitary use. The first problem was what to call the new weapon. Thompson wanted something different, a name that would distinguish it from its larger predecessors. He considered autogun and machine pistol but finally decided on submachine gun to denote a small, handheld, fully automatic firearm chambered for pistol ammunition. To honor the man most responsible for its creation, the weapon was officially named the Thompson Submachine Gun, but the press quickly dubbed it the Tommy Gun.

The Tommy gun became notorious in the 1920s and 1930s because of its misuse by Prohibition-era gangsters and Depression-era bandits. The fact that the Thompson (the "Chicago Piano") was featured in a few spectacular front-page crimes did nothing to help its image. The best known of these is no doubt the notorious St. Valentine's Day Massacre of 1929, in which henchmen under gangster Al Capone mowed down seven members of Bugs Moran's gang in a Chicago garage.

The infamous George "Machine Gun" Kelly got his nickname from the Thompson he used one summer night in 1933 to kidnap oilman Charles Urschel from his home in Oklahoma City. Kelly did not have his Thompson when FBI agents finally caught up with him. The terrified outlaw reportedly screamed, "Don't shoot, G-men, I give up!" when they captured him, thus accounting for the feds' famous nickname.

The Thompson was also a favorite of John Dillinger, Public Enemy No. 1. The Dillinger-Nelson gang, along with their sometime-cohort, Charles Arthur "Pretty Boy" Floyd, liked to carry Thompsons with the buttstock removed and a 20-round clip in place of the familiar drum magazine. This way the gun could be concealed under an overcoat and, if shooting was involved, fired one-handed, leaving the other hand free to carry loot, grab hostages, or steer the getaway car.

During a botched robbery on 15 January 1934, Dillinger killed Chicago patrolman William O'Malley with a spray of bullets from

his Thompson. Law enforcement agencies pursued Dillinger and his cronies with furious determination. The gang used Thompsons to blast their way out of an FBI dragnet at the Little Bohemia Lodge in Wisconsin in April 1934. However, Dillinger's days were numbered: he did not have his Thompson with him when Melvin Purvis and his G-men shot down the outlaw on a crowded Chicago street outside the Biograph theater.

The Thompson figured prominently in another high-profile crime on 17 June 1933, when Pretty Boy Floyd and his gang murdered four lawmen and a robber in their custody at the Kansas City train station. The reaction to the Kansas City Massacre was outrage, and only the lawmen had Thompsons when they ended Floyd's career on 22 October 1934.

For a time, the psychotic George "Baby Face" Nelson assumed the title of Public Enemy No. 1 after he murdered a federal agent in Wisconsin in April 1934. He became the subject of an FBI manhunt. On 27 November 1934, two agents spotted him near Barrington, Illinois, and a gun battle ensued. Nelson, armed with a Thompson, reportedly charged the FBI agents' car, firing from the hip and killing both agents. However, in the exchange of fire before they died, Nelson was hit seventeen times by bullets from one of the G-men, who was also armed with a Thompson. The criminal escaped from the scene, but his bullet-riddled body was found in a ditch 20 miles away the next day. In this case as in many others, the Thompson submachine gun played a major role in the triumph of law and order over the infamous criminals of the interwar era.

Back in the Field

As criminals and G-men made lurid headlines with Tommy guns, and Hollywood added to its notoriety with a rash of gangster films, the Thompson was quietly adopted by the U.S. government in 1928. The Navy purchased 500 Model 1928s, which helped keep the struggling Auto-Ordnance Corporation in business. Some of these weapons were used by the U.S. Marines in Nicaragua, and it was described as very effective for jungle fighting there. The following year, more Thompsons were acquired by the Marines for their detachment in Shanghai. The Navy Model was also used by the Army and Coast Guard. It utilized the fore grip and sling swivels. The cyclic rate of fire was 700 rounds per minute.

Until the beginning of World War II, the total number of Thomp-

sons bought by the U.S. Army was less than 400, but in 1938 it was adopted as standard issue. With the outbreak of war in Europe, the French government ordered 3,750 Model 1928s and 30 million rounds of ammunition. Orders were also received from England and Sweden.

In the United States, the Thompson had initially been viewed as an auxiliary weapon, but with war coming and given the need to develop an armored force, large numbers were needed. The Model 1928 was simplified for mass production. The result was the M1A1 Thompson Submachine Gun, Caliber AS, which went into full production in 1943. The M1A1 had a 20-round box magazine and selector switch on the left side that permitted full auto or semiauto. This weapon was produced both by Auto-Ordnance and by Savage Arms. More than 1 million Thompsons would be manufactured prior to and during World War II.

Despite its widespread use, the weapon had drawbacks. It was actually heavy at more than 11 pounds, more than the M1 Garand rifle. Additionally, it was difficult to control in full-automatic fire. Like many other submachine guns, it lacked penetrating power. Nevertheless, the Thompsons were popular among specialized troops like the Rangers and Marine Raiders, as well as airborne and armored troops. In close quarters, where stopping power and range were nonfactors, the Thompson was effective. It went on to service in Korea and Vietnam. As for Thompson, he was not able to see the overwhelming success of his gun as a military weapon; he died in 1940 at the age of 80, but he had left his mark on the history of military weapons.

OTHER DESIGNS

While Thompson had worked on perfecting the Tommy, other designers were working on similar weapons. Yet the idea of the submachine gun was not popular in many military quarters. "Cheap and shoddy," "not a proper soldier's weapon," "a tin toy"—these were some of the criticisms directed toward submachine guns in the 1920s and 1930s.[8]

Great Britain and the Sten Gun

One country that resisted the incorporation of the submachine gun into its military was Great Britain. Many British officers thought

that the weapons had only limited application to the modern battlefield because they were so cheaply made and notoriously inaccurate. The focus in the interwar years remained on producing finely made rifles and machine guns. However, the German invasion of Poland jolted the British. Apparently appeasement was not going to stop Hitler, and the German army was on the move. The British, realizing they were far behind in the arms race, turned to the submachine gun as an answer to arming the massive army necessary to defend against the Germans.

The British first purchased Thompsons, but they were too expensive. Using the well-proven German 9mm MP28 as a model, George Lanchester of Sterling Armaments Company developed a submachine gun that took his name. It was a finely machined weapon with a well-finished wooden stock. However, the Lanchester was expensive and time-consuming to manufacture. Faced with the possibility of invasion and having lost a large number of weapons on the far side of the English Channel at Dunkirk, the British needed a quick and cheap way to provide firepower for the Home Guard, volunteers, airfield guards, commandos, and regular soldiers.[9]

To answer that need, two designers at Enfield Royal Small Arms Factory, Major R. Vernon Shepherd and Harold John Turpin, designed a weapon to replace the Thompson and the Lanchester that would be cheaper, easier to manufacture in great numbers, and delivered quickly. Designed in a matter of months in 1940, the result was called the Sten, from the combination of the designers' initials with the first two letters of the factory's location.

The first Sten gun, the Mark I, had a folding wooden fore grip and flash hider. It was a straight-blowback weapon, firing from an open bolt and with a fixed firing pin. The Sten's bolt system and horizontal feed mechanism were derived from the German Schmeisser MP28. It fired a 9mm Parabellum round and fired 550 rounds per minute. It was reasonably well-finished, although it made use of welded stampings rather than traditional machined and forged components; the only machined parts were the bolt and barrel.

The Mark I was followed by the Mark I*, which did away with the fore grip and was made entirely of sheet metal. In 1942, the Mark II was introduced and became the most common Sten model. It was also manufactured in Canada and Australia. An even cheaper Sten, the Mark III, was adopted in 1943.

The Sten was a cheap, all-metal submachine gun that became standard issue for British forces throughout World War II. The Royal Small Arms Factory supplied 4 million to the British Army be-

tween 1941 and 1945. The Sten was a unique weapon that horrified many armaments producers of the old school because it was designed and manufactured "without any consideration for appearance, proportion, grace or high-class finish.... [It] was simply a device for killing people."[10]

Given various nicknames ("Stench Gun", the "Woolworth", and "Plumber's Friend"), the Sten was not popular among soldiers at first. One expert described the Sten as "the ugliest, nastiest weapon ever used by the British Army."[11] In addition to its unlikely appearance, the weapon was criticized for its inaccuracy and had a habit of discharging accidentally; it also had a tendency to jam at inopportune times, usually in battle. One of the most famous Sten malfunctions occurred on 17 May 1942, when a Czech partisan calmly stepped in front of a car containing German General Reinhard Heydrich, the Reichsprotektor (Reich Protector) of Czechoslovakia, at a road junction, leveled his Sten, and pulled the trigger, only to discover that compressed lips on the magazine had prevented it from feeding a round. (The assassin's partner wounded the SS general with a hand grenade; he died later as a result.) Additionally, the "Tin Tommy Gun," as some soldiers called it, lacked the stopping power and reliability of the original Thompson.

Despite the tendency to malfunction, Stens were cheap to make, and the British government distributed them to resistance groups throughout occupied Europe. It was compact and could be easily dismantled for concealment, making it a favorite of underground fighters. Due to its simplicity and ease of production, the Sten could even be manufactured by underground groups who had only the minimum of simple tools available; examples made in Denmark, France, Holland, Israel, and Cyprus have been recorded.[12]

The Grease Gun

The U.S. Army began World War II with the Thompson submachine gun, but there were problems in producing enough Thompsons to meet the demands of the expanding army. Looking for a cheap, effective weapon that could be manufactured in great numbers quickly, U.S. designers studied the process used by the British to churn out the Sten in such great numbers. The result was the M3 Submachine Gun, manufactured largely from steel sheets that were pressed and riveted or welded together. The M3 was greeted with the same derision as the Sten among the troops and was nicknamed

the "Grease Gun" for its resemblance to the mechanic's tool. It fired the same caliber .45 round as the Thompson but was much cheaper and easier to manufacture. The rate of fire was especially slow. In addition, there were numerous design flaws that showed up in combat, and refinements were constantly needed, culminating in the M3A1, which officially replaced the Thompson in 1944. Thousands of M3s remained in service until the 1960s.

Soviet Designs

In the Soviet Union, Vasily Degtyarev incorporated some of Hugo Schmeisser's principles from the MP28 design into his own, culminating in the Pistolet Pulemyot Degtyarova (Degtyarova Machine Pistol) 1934 (PPD34). The PPD34 was a simple blowback weapon with a wooden stock and a drum-shaped magazine containing 71 7.62mm cartridges, the standard Soviet handgun cartridge at the time. Well-made, it could fire 900 rounds per minute. A later version, known as the PPD40, was issued in 1940. It was simplified to ease manufacture.

In June 1941, vast numbers of Soviet men and equipment were overrun and captured in the first weeks of the German advance into the Soviet Union (OPERATION BARBAROSSA). The Soviets hastily raised new formations, and a cheap, easily manufactured weapon was needed. Georgi Shpagin led a team to develop such a weapon. The result was the Pistolet Pulemyot Shpagina (Shpagina-Type Machine Pistol) 41 (PPSh41), which was crudely made and finished, using a minimum amount of quality materials. Requiring no machined parts, it could be turned out quickly in great numbers. The Soviets, hard-pressed by the German Army, even used old M1891 rifles to speed manufacturing. They cut the barrels of the old rifles in half, thereby providing the barrels for two new submachine guns.

The PPSh41 ("Pah-Pah-Shah") was a simple blowback weapon that, like the PPD34 and PPD40, fired the standard Soviet pistol cartridge. It was made largely from sheet-metal stampings riveted and welded together. It used a 71-round drum, similar to the PPD40. The barrel had a distinctive slotted jacket around it. It was a simple and tough weapon. It was not delivered to Soviet troops until 1942, by which time the Red Army was fighting for its life. It was issued on a scale unsurpassed by any other such weapon, becoming the very symbol of the Soviet infantryman. The PPSh41 proved it-

self time and again in combat. Very reliable even during Russian winters, it continued to function under the worst conditions, withstanding dust, mud, snow, and ice. Due to the simplicity of design, it could be used effectively by conscript soldiers with little technical training and formal education. By the end of the war, more than 5 million of these cheap, easy-to-use submachine guns would be manufactured. The design was so sound that the German Army seized any captured weapons for their own use, even modifying some to fire their own 9mm round.

After the war, the PPSh41 would be supplied in great numbers to Soviet client states and to communist guerrilla forces. It was also copied by other countries, particularly in China, where the result was the Chinese Type 50. The PPSh41 and its derivatives would become the symbol of guerrilla forces around the world until it was replaced by another Russian weapon: the AK-47 assault rifle.

CONCLUSION

By 1945, there were a multitude of SMG designs in production. It had grown in importance, equal to the rifle in small unit operations. It had to overcome skeptical prejudice in the early days, and its acceptance was slow. Some historians have suggested that the Spanish Civil War (1936–1939) brought the weapon into prominence, but weapons expert Ian V. Hogg points out that recent research reveals that less than 4,000 submachine guns reached Spain during its civil war, compared to a half-million rifles provided by Russia alone. Hogg suggests, "It was, in the eyes of many soldiers of many nations, a remedy looking for a disease."[13] With the exception of Germany, and to a lesser extent Russia, the weapon just did not fit into the preconceived tactical theories in most armies of the day.

The outbreak of war in 1939 and the new style of mobile warfare caused military leaders to reconsider the submachine gun and its utility on the battlefield. Additionally, it was simple and cheap to make, and it could be used by hastily enlisted troops without extensive training, making it ideal for large conscripted armies suddenly mobilized for war.

For these reasons, the submachine gun came into its own during World War II. They became the mainstay of specialized assault forces, such as storm troops, airborne soldiers, and assault pioneers (engineers). The weapon was especially useful during combat in ur-

ban areas, where its lightness, portability, high rate of fire, and ease of reloading gave it great utility in close quarters. Submachine guns were also used by signalmen, drivers, ammunition carriers, and rear-area headquarters and staff personnel who needed a weapon more practical than a rifle. Commandos and other special forces, who were often expected to engage in close-range combat, also benefited from submachine guns. By the end of World War II, the weapon had proved it had an important role to play in modern warfare.

NOTES

1. Ian V. Hogg, *The Story of the Gun* (New York: St. Martin's, 1996), p. 134.

2. Roger Ford, *The World's Greatest Machine Guns: From 1860 to the Present Day* (New York: Barnes & Noble Books, 1999), p. 100.

3. Ibid., p. 97.

4. Craig Philip, *The World's Great Small Arms* (London: Amber Books, 1993), p. 123.

5. Thompson was instrumental in adapting the British Enfield rifle to caliber .30 ammunition and producing it as the M1917. Promoted to brigadier general, he was responsible for the supply of small arms and munitions to the AEF in France, for which he received the Distinguished Service Medal. In December 1918 he retired from the service for a second time.

6. Quoted in William J. Helmer, *The Gun That Made the Twenties Roar* (London: Colliar-Macmillan, 1969), p. 25.

7. Ibid., p. 72.

8. Philip, *The World's Great Small Arms*, p. 125.

9. Ian V. Hogg, *Guns and How They Work* (New York: Everest House, 1979), p. 145.

10. Hogg, *The Story of the Gun*, p. 141.

11. Philip, *The World's Great Small Arms,* p. 127.

12. F. W. A. Hobart, *Pictorial History of the Sub-Machine Gun* (New York: Schribner's Sons, 1973), p. 84.

13. Ian V. Hogg, *Submachine Guns* (London: Greenhill Books, 2001), p. 10.

CHAPTER 6

Preparing for the Next Round

As the submachine gun evolved during the interwar years, the development of the machine gun followed a deliberate, less radical path. Many World War I machine guns were still in use during the interwar years, and some would be used during World War II. This does not mean, however, that there was no new development. As weapons experts like Ian Hogg point out, everyone had machine guns by late 1918, but not everyone was happy with the products on hand. Thus development during the interwar years progressed along two lines—the light machine gun and the heavy machine gun (with one exception; see below).

MOVING FORWARD IN TACTICS AND DESIGN

The heavy machine gun—the bulky, recoil-operated, hard-to-maneuver weapon of trench warfare—was already well-established, though tactics for using them lagged far behind. The light machine gun debuted during the latter stages of World War I. Its continued development after the war centered on finding portable firepower for infantry on the attack. Most of the World War I heavy machine guns like the Vickers, the MG08, the Browning M1917, the Schwarzlose, and other older designs depended on recoil to operate and were heavy by design. However, there developed a trend toward

gas-operated guns, which functioned by tapping off gases produced when a cartridge is fired. Building on the concepts found in the Browning Automatic Rifle and the British Lewis, this new breed of light machine gun was made to provide the infantry squad increased firepower, relieving them of the burden of lugging around heavy machine guns, usually controlled at company or battalion level. This increased firepower at the squad and platoon levels would greatly influence the evolution of infantry tactics between the wars.

LMGs

The new models of the LMG class shared certain characteristics, though they were either belt-fed or used magazines or drums. They had a high rate of fire that caused the barrels to overheat rapidly, so it became necessary to design barrels that could be replaced during combat. Although deployed and fired by one man, they could not be maintained without at least a two-man team. Thus, they were the first crew-served weapons to be assigned to rifle squads. These characteristics were generally present in most of the guns designed after World War I.

With World War I over, the British began searching for their own equivalent of the BAR to replace the overweight Lewis. Trials were held, and the frontrunner appeared to be a design by Adolphe Berthier, a French general. He had developed it in 1918 and tried to sell it to the U.S. Army, but there were several unresolved problems with the design and the Americans chose not to adopt it. Berthier then tried to sell his ideas to the British, but they initially demurred because rectifying the weapon's design problems would prove too costly. Nevertheless, they thought the design had potential. In 1925, Berthier sold the rights in his design to Vickers. Vickers took the time to perfect the design. The resulting Vickers-Berthier Light Machine Gun, as it became known, was gas-operated, chambered for the .303-inch round, and was fed from a top-mounted banana-shaped box magazine like that pioneered by the Danish Madsen LMG. It was reliable and trouble-free. However, the British Army remained unconvinced and conducted a series of trials spanning several years. In 1934, the Czechoslovakian-made ZB vz/27 entered the never-ending trials. The Czech weapon, an improved model of the earlier ZB vz/26, was manufactured by the firm of Ceskoslovenská Zbrojovka at Brno.[1] It was a magazine-fed LMG designed by Va-

clav Holek. The weapon is gas-operated, with an ingenious quick-change barrel and a top-mounted magazine.

After a series of 27 separate tests, the Vickers-Berthier and the ZB vz/27 were submitted to an exhaustive final exam that included firing, being buried in mud and sand for predetermined periods, firing again (with only very superficial cleaning), and finally a 10,000-round endurance test. Both weapons passed these tests and were next submitted to accuracy tests at ranges of 500–2,500 yards and an additional 30,000-round endurance test. In the final shootout, the Czech weapon proved mechanically far more reliable and accurate than the Vickers-Berthier. Several modifications were made to the original design, and the result, the ZB vz/33, was put through an additional set of trials in January 1934, in which several guns fired at least 140,000 rounds each without malfunction. Still, there were doubters on the British Army staff, so another endurance test was held in August 1934. This finally did the trick, and the redesignated ZBG 34 was selected as the British Army's new light machine gun (the Vickers-Berthier LMG did not totally lose out, however; it was adopted by the Indian Army and later served usefully as a vehicle gun in the North Africa desert campaigns during World War II).

The Bren Gun

The fact that a Czech design bested a British entrant speaks volumes about the performance of the new weapon. The original Czech model was chambered for the German 7.92mm Mauser round, but in British service, it was adapted to the standard .303-inch round used in the Lee Enfield rifle and Vickers MMG. It was also given a new name, the Bren gun, taken from its birthplace in Brno and the new factory at Enfield where it was produced.

The Bren is a gas-operated weapon that holds the bolt group to the rear between firing. It uses 28-round magazines. It also has a second barrel for quick changing. It is a versatile weapon and soon became the base of fire for the British infantry squad, the first line of defense against air attacks, and also the armament of the universal weapons carrier and several models of the scout car. It was known for phenomenal accuracy; with a good barrel, a competent gunner could put an entire magazine into the bulls-eye of a practice target up to 600 yards. Most Bren guns were first produced at Enfield, but lines were started up in Canada and later during the war in Australia and India. Many Bren guns were sent into occupied Eu-

rope to equip the various underground organizations fighting the Germans. It was prefect for such a role because it could be easily field-stripped and used with a minimum of training, thanks mainly to its simple operation and rugged construction. On the battlefield, it would repeatedly prove accurate and reliable in all climes and conditions; many experts consider it the best light machine gun ever produced.[2] It would stay in production until 1971 and saw first-line service in armies long after that.

Browning

In the United States, gun maker John Browning had also been working on a lighter machine gun: the M1919. It is somewhat misleading to place the M1919 in the LMG class because it was notably heavier than others and needed a heavy tripod mount to fire from; thus, it is actually in the MMG category. It was a caliber .30 recoil-operated machine gun with an air-cooled barrel that employed many of the features of the Browning M1917. By using a heavier barrel (with a heavily perforated outer casing), the M1919 could fire more than 60 rounds per minute for more than 30 minutes without overheating. It fired a 250-round fabric belt and weighed 44 pounds with tripod. A later model was fitted with a rifle-style butt and bipod for the light machine gun role. The M1919 was a tough and reliable weapon, and the M1919A4 became the standard U.S. medium machine gun throughout World War II and into the 1960s. Thousands are still in service around the world.

OTHER DEVELOPMENTS

In France, the government armories at Chatellerault and Saint Ètienne, turned out the 7.5mm Fusil Mitrailleur Modèle 14/29, which had been developed to replace the ill-fated and unpopular Chauchat used during World War I. It was basically a modification of the BAR design with a top-mounted box magazine. A later revision resulted in the Modèle 31, which was also magazine-fed, but from a unique, 150-round, side-mounted drum. It had a unique double trigger system that permitted semiauto and automatic fire.

Elsewhere in Europe, arms manufacturers in Austria, Finland, Sweden, and Switzerland all produced more or less successful LMG

designs in the late 1920s and 1930s. Two Swiss companies, Waffenfabrik Bern and SIG, produced lights, but both were too expensive for mass production.

The Soviets were latecomers to machine-gun development generally. Prior to World War I, the czarist army bought machine guns from other countries and manufactured some under license. For this reason, Russian machine-gun development and production had to start virtually from scratch after the Russian Revolution. A top priority was the development of a light machine gun to replace the Lewis, Hotchkiss, Madsen, and Chauchat left over from World War I. It had been difficult to get spare parts, and the weapons' various ammunition calibers placed stress on the logistics system. The Soviets also had many water-cooled Maxims left and the factories to build them, so the initial effort went into developing a lightweight conversion of the Maxim. Several designers were given the task of coming up with independent designs for the conversion. F. V. Tokarev came up with the winner, in which he modified the Maxim by replacing the water-cooled sleeve around the barrel with a slotted jacket to produce a light, air-cooled weapon with a rifle butt and pistol grip. After extensive testing, the Maxim-Tokarev was finally approved in 1925 as the future light machine gun. However, Soviet troops complained that the weapon was still too heavy to meet the requirements for a light machine gun. Modifications were made, but the Soviet high command realized that the weapon was still only the extension of an outmoded design. So they gave another designer, Vasily A. Alexeyevich Degtyarev, the task of developing an entirely new light machine gun.

Degtyarev's first successful model was the Degtyareva Pulemet (DP), which appeared in 1926. The DP was a simple, gas-operated weapon with only six moving parts. It proved very reliable in the harsh conditions it would be subjected to in the coming war. It fitted a visually distinctive drum magazine on the top of the weapon that held 49 rounds. In action, it was served by a two-man crew. The DP, including the infantry, tank, and aircraft versions, would be used in very large numbers throughout World War II.

A close relative to the DP, the Degtyareva Pulemet Tankovii (Degtyarev-Type Machine Gun, or DT) was first issued in 1929. It was designed for use in armored vehicles but was basically the same gun as the DP. Both weapons saw service with Loyalist forces during the Spanish Civil War, during which some deficiencies in design were noted. Modifications were made, and the two guns went on to become the principal squad and antitank machine guns in the Red

Army for most of World War II. In 1944, the DP was modified into the DPM. Although there were some problems with the fragile tin drum magazine, the DP, DT, and DPM proved remarkably reliable under the harshest conditions.

LMGs AND THE AXIS

The Axis Powers, or rather nations that would become the Axis, were also developing indigenous LMG designs; the Germans would take a different tack than most others.

Germany

The German Army finished World War I convinced that the machine gun was the authority on the infantry battlefield. In the years that followed, the Germans came to the conclusion that rather than using two different weapons in the light and heavy roles, a single general-purpose design that could be modified to meet a range of requirements would be the best solution, economically and tactically, for infantry firepower.

However, before the new ideas could be put into action, Germany had to overcome restrictions under the Versailles Treaty. The Allies had taken pains to dismantle the German war machine; under Versailles the country was forbidden from manufacturing virtually all types of armaments, including heavy machine guns. The German Army was limited to 100,000 men, with no tanks, mobile antiaircraft weapons, or other heavy weapons; 792 HMGs and 1,134 LMGs were allowed.[3] The rest of the German automatic weapons were supposed to pass into Allied hands for reallocation, disposal, or scrapping. Many historians point out that the strictures of Versailles set the stage for the rise of social nationalism (Nazism) in Germany and, eventually, World War II.

It took some time for Germany to recover from its defeat and the economic ruin that followed. However, by the early 1930s a clandestine revitalization of the army had begun. The German military, under General Hans von Seekt, took measures to get around the limitations imposed by the treaty. Focusing on theory, doctrine, lessons learned from World War I, and an intense training program, von Seekt sought to fashion the nucleus of a new army that could be ex-

panded at some time in the future. While dealing with tactics and doctrine, there was also an effort to address the technological needs of this new army, including the development of new weapons.

One clause of Versailles prevented Germany from developing sustained-fire weapons, which in 1919 meant water-cooled machine guns. The Germans had fought using the Maxim MG08, augmented by the MG08/15, the Dreyse MG13, and the Bergmann MG15. These weapons were all obsolete, and as the army developed new tactics and operational concepts, it began to question the utility of heavy, water-cooled weapons. The peace treaty forbade the production of military small arms, but it did not say anything about designing new weapons; nor had it broken the prewar links, agreements, and licensing arrangements among European weapons manufacturers. Therefore, during the interwar years a considerable amount of German weapons development work went on, either in secret or in countries prepared to turn a blind eye toward the legality of the situation in return for a share of the product. Holland, the Soviet Union, Sweden, and Switzerland provided assistance in that vein to Germany during this period. In Germany itself, only one company, Simson & Cie of Suhl, just south of Erfurt, was permitted to manufacture machine-gun parts and complete machine guns, but only in limited numbers to equip and support the Reichsheer, as the German Army was known under the Weimar Republic.

Several German light machine guns were developed by German engineers working abroad, particularly in neighboring Switzerland, where in 1929 Rheinmetall, the German arms firm, had made an important acquisition by purchasing Waffenfabrik Solothurn AG. Although the factory had originally specialized in watch making, it converted to arms manufacture soon after World War I. After Rheinmetall gained control, the German company began to put its own designs into limited production through the factory at Solothurn. Rheinmetall had also entered into an agreement with Steyr in Austria to manufacture weapons from German designs. A new company was formed, Steyr-Solothurn A.G. of Vienna, which then offered the weapons on the open market. Through such arrangements, German weapons designers and manufacturers were able to get around the strict limitations of the Versailles Treaty. The first order of business, as least for automatic small arms, was to develop a gun to replace the MG08.

The first weapon to appear under the Solothurn name was developed at Rheinmetall's Sommerda factory by Louis Strange and then passed to Solothurn for production and sale. This weapon was

known as the Solothurn S2-100 Machine Gun, which was manufactured from a Rheinmetall design of the early 1920s. The appearance of the S2-100 was only a hint of that to come.

Around 1930, existing models of the old Rheinmetall-manufactured Dreyse MG10 were stripped of their water jackets, fitted with a stock and bipod, and converted to the LMG role. This weapon was designated the MG14. Having adapted the older machine gun, the German engineers then turned to developing an entirely new weapon, the MG13, which was a lighter gun than its predecessors. It was air-cooled with a perforated barrel and a skeleton butt that could be folded to lie alongside the receiver. It was magazine-fed rather than belt-fed. There has been some confusion about this weapon, and it was thought for some time that the MG13 was a modification of an earlier model, the MG10. However, it appears that the naming of the weapon may have been a subterfuge designed to convince the Allied Control Commission, the enforcement arm of the treaty, that the gun was an old design and thus exempt from the Versailles ban on new machine-gun development.[4]

Mauser at Oberndorf am Necker was working on a design by Ernst Altenberger for a light machine gun of similar capabilities to the M30 (a modification of the Solothurn S2-100). This resulted in the new LMG32, a first for Mauser. Altenberger's design had several unique features, including a bolt-locking procedure and barrel-changing method, but it also had several unsatisfactory aspects.

As time passed and the Allied Control Commission became increasingly ineffective, Rheinmetall went back into the armaments business openly. In 1932, the Germans began producing the MG15, which was originally intended for use as a light machine gun for aircraft installation in Adolf Hitler's Luftwaffe. It was to become the Luftwaffe's standard flexible-mounted machine gun during that service's formative years. It was later pressed into use as a light machine gun on the ground. The MG15s were also produced under license in Japan for the Imperial Japanese Army (IJA) as the Type 98 and for the Imperial Japanese Navy (IJN) as the Type 1.

Part of the MG15's design would be incorporated into the MG17, a belt-fed gun with a higher cyclic rate of fire than the MG15—around 1,200 rounds per minute. It was frequently mounted in multiples (twins or quads) in aircraft and on pedestals as light antiaircraft guns. A variant, the MG131, would succeed the MG15 as the Luftwaffe's standard machine gun throughout World War II.

After looking at the MG15 and the LMG32, the German Army ordered Rheinmetall's Louis Strange to provide a single gun that

was capable of filling both the LMG and HMG roles. This project would be developed at Rheinmetall's Dusseldorf factory and incorporate the best aspects from both designs. Ideally, the weapon would be adaptable as an individual weapon in the assault model or as a crew-served, sustained-fire weapon in the support model.

German GPMGs

Experience with the MG08/156 had proved that a light machine gun in the assault mode could not be belt-fed, so the saddle drum developed for the MG15 was employed, feeding rounds from different sides alternately to preserve balance and weight distribution. The result of the development process was the Maschinengewehr 1934 (MG34), a new machine gun that would eventually provide the foundation for one of the best infantry weapons of World War II.

The MG34 operates from short-recoil action and is chambered for 7.92mm rifle ammunition. It is fed from a 50-round belt or from a 75-round twin drum that sits across the top of the gun like a saddle. Capable of a cyclic rate of fire of about 900 rounds per minute, it was equally effective when fired from a bipod or when mounted on a tripod for sustained fire. Given the extremely high rate of fire, the Germans treated overheating by making the barrel interchangeable. The MG34 combined the sustained fire rate of the heavy MG with the relatively low weight of the light and thus became the first member of the new family of weapons: the general-purpose machine gun (GPMG).

The action of the MG34 was the most complex of any machine gun up to that time. Despite this characteristic, the MG34 was a very successful design. It went into production in 1935 and was produced for 10 years. The MG34 was an excellent weapon and from its basic principles sprang a succession of even more efficient general purpose designs, starting with the MG42 and leading to the postwar MG3 (discussed in later chapters).

Japan

The Imperial Japanese Army had only minor involvement in World War I and thus had made little changes to its machine guns. However, in the 1920s Japan made inroads into Manchuria and began to take a more aggressive stance on the international stage. The IJA re-

alized that its machine guns were largely obsolete and began to look at modernizing its weapons. The first effort at developing a modern Japanese light machine gun evolved from the Type 11 Nen Shiki Kikanju Machine Gun, which first appeared in 1922 (the eleventh year of the Taisho era, thus the designation Type 11) and was based on the French Hotchkiss model. Rather than a Hotchkiss-style ammunition strip, this early light machine gun, designed by Major Kijiro Nambu, uses a five-round clip as the basis for its feed system; these were the same charger clips furnished for the standard Japanese 6.5mm Arisaka rifle. Six clips are placed on a side-mounted hopper that feeds the rounds into the breech system. A simple rachet arrangement, actuated by the rearward motion of the breechblock, pulls the bottom clip in toward the feed mechanism, which strips out one cartridge after another, oiling them in the process.

Theoretically, this mechanism was supposed to allow any rifleman to feed the machine gun with his own rifle ammunition without having to load magazines or belts; however, this was not the case in practice, because the standard 6.5mm round proved to be too powerful for the gun, and a reduced load had to be devised to prevent the cartridge case from rupturing. There were other problems as well, not the least of which was that the oily cartridges mixed with dust and dirt and led to frequent stoppages. Despite such problems, the Type 11 was the standard infantry light machine gun in the IJA in 1941. Other variants on the same design were the Type 91 tank version and the Type 89 flexible gun for aircraft.[5]

Nambu eventually retired as a lieutenant general and in 1928 set up Nambu Rifle Company, which began designing all sorts of weapons. After first dealing with the development of a heavy machine gun (discussed later), Nambu turned his attention toward designing a replacement LMG for the Type 11. This appeared in 1936 as the Type 96. This design abandoned the hopper for a more conventional 30-round overhead box magazine and introduced a barrel change. However, it retained the low-powered 6.5mm round. The requirement for oiling the cartridge remained, but Nambu did away with the Type 11's oiling mechanism and fashioned a magazine loading machine that automatically oiled the cartridges as they went into the magazine. All in all, it was not much of an improvement over the earlier model. The Type 96 never fully replaced the Type 11, and the Japanese would go into World War II with both LMG models.

The Japanese next designed a new tank machine gun to replace the existing Type 91. This was essentially a variation of the Czech ZB vz/26, which the Japanese had probably copied from guns they

had captured from the Chinese Army, which had purchased large numbers. Appearing in 1937, the Type 97 was a very effective gun. Chambered for the more powerful 7.7mm cartridge, it was introduced as a tank gun rather than as an infantry weapon. However, the Type 97 was completely unsuited for this role due to the need to change barrels frequently and because the magazine was located on the receiver top, which is impractical for a tank-mounted gun. A number were fitted with bipods, and the gun proved to be better suited as an infantry weapon. However, the Japanese had difficulty manufacturing enough weapons to meet the demands of tank crews, much less those of the infantry.

The Japanese followed two years later with the Type 99, another copy of the Czech ZB vz/26. Also chambered for the heavier 7.7mm round, it needed no lubrication device and was a little heavier than the Type 96. Closer attention was paid to manufacturing tolerances in the Type 99, and the result was a light machine gun as good as any in Europe at the start of World War II. However, Japanese war production could not keep up with demand, and the IJA would fight with a mix of Type 11s, 96s, and 99s; the mixture of models and calibers strained the system supplying the field. Interestingly, all three Japanese light machine guns could be fitted with the infantry bayonet for close-quarters assault.

Italy

Italy, one of the victors of World War I, was not constrained by the provisions of the Versailles Treaty. During the interwar years, it developed imperial ambitions. Since most were focused in areas where terrain dictated that much of the fighting was by dismounted infantry, the Italian Army needed an effective light machine gun. The Italians had emerged from World War I with only one Italian-designed machine gun in service, the Fiat-Revelli M1914. Italy's light machine gun was the Lewis, but it also employed the Vickers, built under license at the Vickers-Terni factory. Wanting to modernize the army, the Italians sought new weapon designs.

The first new design came from Tempini of Brescia, a firm that had manufactured Fiat-Revelli guns during the war. This gun was the Brixia M1920 machine gun. It had deficiencies, and the Italian Army bought only a handful of prototypes. So the Italians published specifications for a new light machine gun. The first response came from Breda, which produced the Tipo 5C in 1924. This weapon had

a unique fixed magazine permanently attached to the right side of the receiver. This magazine had to be reloaded by inserting a horseshoe-shaped, 20-round clip. There were some obvious disadvantages to this system, and the Italian Army bought only a limited number as the redesignated Modello 1924.

In ensuing years, other LMG designs were submitted to the Italian Army and several trials of different models were held, but it was not until 1935 that the 6.5mm Breda Modello 30 was adopted. Breda had acquired the Safat works from Fiat when that company decided that its destiny was not in the armaments field. The Breda Modello 30, little more than the reworked Model 1924, was a simple blowback design fitted with the same horizontal, nonexchangeable, 20-round box magazine that hinged forward for loading. Since the magazine had to be reloaded rather than exchanged for a full one, the gun was slow to reload. Nevertheless, the Breda Modello 30 became the standard Italian light machine gun of World War II.

THE RISE OF THE HMG

While a resurgent Germany developed the general-purpose machine gun, other countries still saw a need for both heavy and light machine guns and continued to work on perfecting heavys, since the majority in service at the end of World War I remained largely unchanged for the next twenty years. They had proved their utility in combat, and most nations saw little need to divert precious resources to improve battle-tested designs. Consequently, most nations went into World War II with many of the same guns that they had used in the earlier conflict. The British continued to rely on the Vickers .303-inch Mark I HMG. The Soviet Union manufactured more PM1910 Maxim guns and would keep them in service until the end of World War II, manufacturing more than 600,000 units.

Yet there were innovations to HMG designs during the interwar years. During World War I, the early tack was to use rifle rounds to simplify ammunition supply. However, there came the need for larger machine guns firing a heavier, long-range bullet for antiaircraft and antiarmor roles. In the United States, the prolific gunsmith John Browning introduced a successful heavy to go along with the M1917 and the BAR. The need for a heavier gun probably drew inspiration from the 11mm Hotchkiss Balloon Gun, used with some success to shoot down enemy observation balloons with incendiary

bullets during the latter stages of World War I. The first difficulty to overcome in the development of a new U.S. heavy was to determine which round was best. Browning scaled up his successful M1917 design to create a water-cooled gun that fired the French 11mm round, but its bullet proved ineffective. By the end of the war, the Americans had captured some German Mauser antitank rifles. These weapons fired a .50-inch (12.7mm) round that had a high muzzle velocity and excellent antiarmor characteristics. The decision was made to experiment with this round, which was approximately four times as heavy as standard rifle ammunition.

United States

Several years after the war Browning was able to adapt his M1917 to the heavier bullet. The result was the U.S. Machine Gun, Caliber .50 inch, M1921. It was subsequently modified and redesignated the M1921A1. These weapons were water-cooled, requiring constant water circulation and supply to cool the barrel during firing. They were ultimately used as antiaircraft guns and were installed on many U.S. Navy vessels.

Meanwhile, Colt and Rock Island Arsenal were experimenting with air-cooled caliber .30 guns based on the Browning design, modified for installation in aircraft. In 1928, they introduced a .50-inch air-cooled gun for aircraft mounting, designated the M2. It was also produced for use on the ground, but without the coolant effect of the plane's slipstream, it proved unreliable due to overheating of the barrel after only 75 rounds had been fired.

To compensate for heat buildup, Browning modified the M2 to incorporate a heavier barrel; the result was the M2HB Heavy Barrel. The M2HB's rate of fire was somewhat lower than the original design, essentially a .50-inch version of the caliber .30 M1917 Browning. The weapon was recoil-operated, air-cooled, and fired about 450 rounds per minute. It uses a cartridge of various weights and types at high muzzle velocities, with roughly five to seven times the energy of full rifle-power ammunition. The Browning (known commonly as the .50-Cal) went on to become one of the most widely used and praised HMG designs ever. An exceptionally flexible weapon capable of filling many roles, during World War II it was configured in various fixed, flexible, and field mounts for use aboard ships, aircraft of all sorts, and a range of vehicles, from main battle tanks to small scout cars and trucks. Almost 2 million were pro-

duced during World War II, and more M2s have been manufactured than any other U.S. machine gun.[6] In addition to World War II, it was used in Korea, Vietnam, Grenada, Panama, and the 1991 Gulf War. More than 30 countries possess M2s of various types in service, and in 2004 it was still being manufactured in two locations in the United States and in Belgium.

Soviet Union

Because of the initial difficulties in establishing an indigenous machine-gun industry, the Soviets had to develop mediums and heavys for their forces, still armed with the Maxim 1910 model. As part of the first Five-Year Plan for reequipping the Soviet Army, the Maxim 1910 underwent modifications to modernize the design. However, as was the case with the light machine gun, the Soviets wanted a new design to replace the older weapon. In the late 1920s, specifications were published for a replacement for the Maxim. The new weapon was to be similar in mechanism to the DP and DT guns to ensure uniformity of training. It was to be air-cooled and belt-fed, with a rate of fire of 500 rounds per minute, weigh not more than 30 kilograms (66 pounds), and a tripod mounting with or without wheels.

In 1930, Vasily Degtyarev, in conjunction with G. Sergei Shpagin, produced a design that met the Red Army specifications. The Degtyarev Stankovy (Degtyarev Mounted, or DS) was a tripod-mounted machine gun in caliber 7.62mm using the same gas-piston and lock system as the DPs and DTs, but with a belt feed and a very heavily finned barrel. It was adopted in 1939, but there were serious problems with the design. The weapon ripped cartridges to pieces when withdrawing them from the belt, and it jammed in dusty conditions and froze up in cold weather. Ultimately, only 10,000 DS guns were made; production of the Maxim 1910/30 was restarted.

While trying to perfect the new MMG design, the Soviets also recognized the need for a true heavy machine gun that could be used against aircraft, light armor, and similar hard targets. Degtyarev was again called upon, although he was still busy trying to perfect the DS. He devised a caliber .50-inch gun that employed his locking and gas-piston system. Using a drum magazine, the new weapon, designated the Degtyarev Krupnokalibernyi (Degtyarev Heavy Caliber, or DK), was approved in 1933. The gun was reasonably well designed, but during tests users complained of a low cyclic

rate of fire and difficulty in changing the bulky drum magazines. Production was stopped, and Degtyarev went back to the drawing board. Once again, he called in G. S. Shpagin to assist in modifying the design, particularly with regard to the feed problems.

The result of this collaboration was the 12.7mm Degtyarev-Shpagin Krupnokalibernyi (Large Caliber Degtyarev-Shpagin) 38 (DShK 38), submitted for initial testing in 1938. The DShK was similar to the Browning M2 but was gas-operated. Degtyarev contributed the gas operation and locking system from his DP LMG series, and Shpagin devised a novel way to extract incoming rounds from the belt by means of a rotary-feed cylinder. The DShK 38 saw extensive service during World War II; it became the infantry heavy-support machine gun and also became the universal air-defense machine gun in the Red Army; by the beginning of 1944, 8,000 were in the field.

Europe

Other nations produced heavy machine guns during the interwar period. Initially, the British continued to use the .303-inch Vickers Mark I, adopted in 1912. Eventually they produced an enlarged version of their Mark 4 and Mark 5 guns firing the .50-inch round developed for the Browning M2. Later, Rolls-Royce started but did not compete a project to develop a .50-inch machine gun. During World War II, the British would rely largely on the Browning .50-Cal for its HMG needs.

France produced the Hotchkiss Modèle 30, merely an enlargement of the proven Hotchkiss design to fire a 13.2mm round. The French high command's conceptualization of the next war led to a failure to develop a new HMG design during the interwar years. Believing that the Maginot Line would provide an impenetrable defense, they saw the role of the infantry as merely having to carry out patrols and nuisance raids against an enemy that sat impotently on the other side of the fortified line. It was thought that these activities would always be carried out under the cover of fortress guns; thus to the French mind there was no need for a heavy-support machine gun. Little effort was made to develop a new French Army heavy prior to World War II.

Italy had also been busy during the interwar years on its own heavy. In 1931, the Italians produced the Breda Modello 31 in caliber 13.2mm. This weapon was used primarily as secondary armament for tanks, although it could be tripod-mounted for use by the

infantry. The Modello 31 was short-lived, replaced by the Breda Modello 37, which fired a heavy 8mm round at high velocity, making it accurate to considerable distances (out to 2,000 meters). This was probably the best of the Italian small arms, but it had several problems. The Breda 37 used lubricated ammunition, which invited stoppages in the deserts of North Africa. Nevertheless, it became the standard Italian heavy machine gun during World War II. When the British captured large numbers of these in North Africa, they put them back into service with the Long Range Desert Group.

In Czechoslovakia, the engineers at the Brno factory also developed a heavy machine gun. The ZB vz/37 was an air-cooled, belt-fed gun with an action similar to that of the vz/26 Bren gun. This weapon, with versions chambered for either 7.92mm or 15mm rounds, was compact, reliable, and extremely accurate. The Czechs, as well as the Germans who put it into service as the MG37(t), used it as an infantry weapon mounted on a tripod and in small numbers as an antiaircraft weapon. However, the British obtained a license from the Czechs and produced the weapon as the Besa in both calibers. The Besa was used in rifle caliber as secondary armament for tanks and in 15mm as primary armament for armored cars and light tanks. It was a very accurate weapon and remained in British service until the mid-1950s.

Japan

In addition to working on a light machine gun during the interwar years, the Japanese also developed a series of new heavy machine guns. Japan had relied on the Hotchkiss, but in the 1920s it began to modernize its weapons inventory. Kijiro Nambu, who had already designed an automatic pistol and a light machine gun, set about to develop a heavy-support machine gun. The result of his efforts was the Taisho 3, essentially built around the Hotchkiss and chambered for the 6.5mm Arisaka rifle cartridge. The manufacturing processes for this weapon were less than exact, resulting in mechanical problems. One of the most serious was that the rifle round created too much pressure in the breech, leading to stretched cartridges, extraction problems, and stoppages. The problems were so significant that a new, less-powerful 6.5mm round, the Taisho 3 cartridge, had to be developed for the weapon. Also, an oiling mechanism was added; these two modifications improved the reliability.

When General Nambu retired and formed his new company, he was charged by the Japanese high command with producing a re-

placement for the Taisho 3. In 1932, he brought forth the new Type 92 HMG, essentially a modification of the earlier Taisho 3. It became the standard Japanese HMG and was one of the most widely used guns in the IJA during World War II. With a low rate of fire, the Type 92 was nicknamed the "Woodpecker" by Allied troops during World War II on account of its unmistakable stuttering sound when fired.

The Japanese Kwangtung Army had been fighting sporadically with Chinese warlords in the area, but they also became involved in an ongoing, low-intensity conflict with the Russians on the Manchuria-Siberia border. This was usually manifested in raids against outposts as opposing forces jockeyed for control of the border area.[7] One result of this conflict was the realization by the Japanese high command that a heavier machine gun was needed that could sustain fire for long periods. Therefore, the army demanded a 7.7mm, water-cooled, heavy-barreled machine gun that could be used in enclosed places such as concrete pillboxes. One answer was to modify the Type 89 fixed aircraft machine gun, a copy of the British Vickers air-cooled aircraft gun. Adding a heavier barrel and wrapping it with a water-jacket, the Japanese essentially converted the weapon back into what it had started out as: a water-cooled Vickers. This weapon was known as the Type 96 Heavy Machine Gun. Only a small number were manufactured in 1939 for use by the Kwangtung Army, and very few saw service in other theaters.

Thus by the beginning of World War II Japan was not much better off than it had been in 1918. There were few innovations in the interwar years, and the resulting polyglot of weapons meant that the IJA entered the war with three different 6.5mm cartridges and four different 7.7mm cartridges. Additionally, industrial capacity could not meet military demands, so a mixed bag of light and heavy machine guns in a range of different calibers filled the stocks. These factors would have a significant impact on the supply system once war began in earnest.

CONCLUSION

While the heavy machine guns of the interwar years were primarily developed for infantry, they also were adapted to vehicle use and in some cases to fighters and bombers. With the development of the tank and mechanized warfare, the heavy machine gun came into its own as secondary armament on all types of armored vehicles. The tank main gun was for long-range targets, but something was

needed for the close-in fighting to protect tanks from dismounted infantry, sappers, and anyone else who would harm tank and crew. The machine gun proved to be the perfect weapon for this task.

By the beginning of World War II, all the major military powers had a range of choices of LMGs, MMGs, and HMGs. Many had been tested in combat during the 1930s in places like Manchuria beginning in 1931 and the Chaco Wars between Bolivia and Paraguay in 1932. The Spanish Civil War began in 1936, and the Italians invaded Abyssinia that same year. In 1939, Germany invaded Poland and Italy invaded Albania. In all of these conflicts, machine guns played an important role, providing firepower for infantry, close-in protection for tanks and other vehicles, and armament for ships, fighters, and bombers. Although the machine gun would not rule the battlefield in World War II as it had in World War I, it would still play a major role in combat on the ground, in the air, and at sea.

NOTES

1. Ian V. Hogg, *Machine Guns: 14th Century to Present* (Iola, WI: Krause, 2002), p. 109. Many historians have reported that the ZB 26 was the weapon that beat out the Vickers-Berthier in the British trials, but it was actually the ZB 27, an improved version of the earlier weapon.

2. Roger Ford, *The World's Greatest Machine Guns: From 1860 to the Present Day* (New York: Barnes & Noble Books, 1999), p. 85; Peter Chamberlain and Terry Gander, World War 2 Fact Files—Machine Guns (New York: Arco, 1974), p. 14; Ian V. Hogg, Guns and How They Work (New York: Everest House, 1979), p. 37.

3. Roger Ford, *The Grim Reaper: The Machine-Gun and Machine-Gunners* (New York: Sarpedon, 1996), p. 175.

4. Ibid.

5. In the late 1920s the Japanese changed the way in which they designated their weapons; instead of dating by the year of the emperor's reign, they used the year of introduction in the Japanese calendar. This calendar differed from the Western calendar (or any other, for that matter), leading to much confusion on the nomenclature of Japanese weapons from the Western perspective.

6. Chamberlain and Gander, *World War 2 Fact Files*, p. 52.

7. With time, these skirmishes increased in intensity until they came to a head in 1939. The Russians launched a major offensive at Nomohan and virtually destroyed an entire Japanese field army. This went unnoticed by many in the West because it happened during the time that the Germans were invading Poland.

CHAPTER 7

Machine Guns in World War II

On the eve of World War II, the world's armies were still heavily dependent on World War I–era weapons and their derivatives despite some 20 years of development and testing. Most formations had a mixture of old and new. Events would soon add new impetus to the continuing saga of the development of the machine gun.

A NEW WAY OF WAR

On Friday, 1 September 1939, a new form of warfare was born: the *blitzkrieg*. German troops poured over the Polish border at six points with tanks and close air support leading the assault. The speed and suddenness of the attack was stunning. Hitler's troops followed up the lightning victory in Poland with more in Norway, Denmark, Holland, Belgium, and then France. The key to the success of the blitzkrieg was the ability of German forces to move rapidly and strike deep into their opponents' rear areas.

These tactics were not really new, as they were similar to the Hutier tactics used on the Western Front in the spring of 1918. They were merely brought to their full potential by the Germans' integration of armor and air forces. The objective, by making full use of surprise, cover, and tactical mobility, was to saturate a small por-

tion of the enemy's defense system with a combination of massed firepower and maneuver to forge narrow penetrations through which German troops could flow through to the depths of the defensive position to unhinge the enemy's command and control and reaction time.

Although the German Army of 1939 was not an entirely mechanized force (the German infantry was still largely foot-mobile), the hallmark of the blitzkrieg was fast-moving offensive operations characterized by speed, firepower, and sudden, overwhelming force. During these types of operations, the machine gun ceased to be a specialized weapon and became instead an integral part of the firepower needed to overcome the enemy at the point of attack. The infantry's need for a sustained-fire weapon that soldiers could carry into battle on the attack was one of the parameters that drove the development of both the German light machine gun and the submachine gun. German tactics were built around the small team armed with light automatics. This gave a small force the firepower advantage and the ability to move rapidly and overcome opposition quickly with a large volume of self-contained automatic fire.

German GPMGs

Such tactics demanded a new approach to the tactical use of the machine gun. Built around the interwar technological innovations by German armament manufacturers and the tactical and doctrinal transformations of the Wehrmacht, the new concept was called the Einheitsmaschinengewehr (Universal Machine Gun) or what would eventually be described as the general-purpose machine gun. The medium was too heavy and immobile to fit the new German style of warfare. In determining how to produce weapons, the Germans decided to do away with the distinctive MMG and LMG designs. Rather than further develop one machine gun for the sustained-fire role and another for the squad's automatic weapon, one machine gun would be expected to fulfill all these tasks and others. Given a tripod, it would serve in the sustained-fire mode, much like a heavy at the beginning. Fitted with a bipod, it would serve as the squad's standard automatic. The gun could also be fitted on tanks and armored cars and even aboard ships for naval air defense and on light vessels and submarines.

The initial German effort to meet the general-purpose needs was the MG34 (see Chapter 6). The MG34 entered service in 1934, the

plan being to replace the collection of existing machine guns in the German Army under the one-gun-fits-all approach. The designers set out to produce the perfect weapon, demanding a higher-quality finish and precision manufacturing than was necessary. Ironically, however, the very quality of the MG34 caused problems. Though it was superbly engineered, the resulting manufacturing process was slow, and German munitions officials anticipated that they would have difficulty replacing MG34s lost in battle, much less produce enough to replace all the German machine guns in the Wehrmacht inventory, even with five factories working three shifts per day. Additionally, the fine tolerances made it difficult to maintain, vulnerable to poor conditions, and susceptible to stoppages caused by sand and dust.

New Production Methods

By 1937, with war clouds gathering, the German Army became concerned that enough MG34s could be manufactured to meet the increased demand. Accordingly, three companies—Grossfuss Metal-und-Lackierwarenfabrik of Doblen, Rheinmetall-Borsig of Sommerda, and Stubgen of Erfurt—were asked to submit designs for a new gun to replace the MG34 that would be easier and quicker to manufacture in great numbers. Rheinmetall and Stubgen submitted gas-operated designs, and Grossfuss proposed a recoil-operated design. Interestingly, Grossfuss, which had no previous experience in weapons manufacture (the company's main line was sheet-metal lanterns), came up with a unique roller-locked breech mechanism that was both simple and resistant to dirt and dust. Ernst Grunow, a design engineer with Grossfuss, knew nothing about machine guns, but he specialized in the technology of mass production, including metal stamping and pressing. Grunow took six weeks off and attended an army machine gunner's course in order to familiarize himself with the actual handling of such a weapon. He wanted to know what the users thought was important in a machine gun. He then returned to his office and designed a machine gun built around an earlier Mauser operating system, incorporating lessons from his stay with the machine gunners and other lessons learned during the first years of the war. The other designs were eliminated, and production began on the MG39/41, as it was designated. By late 1941, large-scale trials were conducted, and after favorable reports all around the weapon was adopted as the MG42 early the following year.

This design was specifically engineered for quick and cheap manufacture. The MG42 was made from steel stampings and pressings rather than machined from solid block. It used rivets and spot welds, rather than fine finishing like the MG34. As a result the cost of the weapon was cut significantly; more important, the manufacturing time was reduced by 35 percent. The MG42 was to become one of the finest machine guns of all time, combining simplicity, ruggedness, and reliability with the firepower of the MG34.

The MG42 incorporated innovative approaches. It used a new form of delayed-blowback action, partly developed from a Polish design obtained when that country was overrun in 1939. It also had a plastic butt and pistol grip. The design also included a quick-change barrel system that permitted a well-trained gunner to exchange barrels in a matter of seconds during combat. The gun had a phenomenal rate of fire—more than 1,200 rounds per minute—far higher than any other machine gun fielded at the time. Because of its light weight, the increased rate of fire meant that accuracy was reduced. However, the Germans were prepared to accept this limitation because they theorized that a machine gunner had only a few seconds to fire at enemies before they took cover. Therefore, it was thought that the more rounds one could fire in this time, the more enemy casualties one could cause.

The MG42 proved deadly effective and fit perfectly in the GPMG role required by German tactical and operational concepts; it would see extensive service on the battlefields of World War II. The standard German infantry battalion employed twelve MG42s in the *schwere* (heavy) role mounted on a tripod. It would prove particularly effective when the German Army was forced on the defensive late in the war. MG42s were also used as armament on virtually every German armored vehicle, from halftracks to Panzers. Regardless of its role, Allied soldiers who faced the MG42 will always remember the terrifying sound ("like ripping canvas"); the MG42 was deadly and effective in the hands of German infantry.

While the MG42 was being developed, the German Army continued work on other designs in case the MG42 design never materialized as a viable weapon. Part of this effort was in improving the MG34 design. The MG34/41 was a radical modification of the MG34 design that was no longer capable of using the spare parts provided for the original MG34. In that sense, it was entirely new. However, by the time that the MG34/41 was perfected, the MG42 had arrived on the scene and proved superior to anything the German Army faced.

Therefore, the MG34/41 was abandoned, and further machine-gun development in Germany virtually ceased for the rest of the war.

OTHERS LOOK TO GERMANY

The Germans' development of the MG42 demonstrated that the old methods of making firearms (machining, milling, turning, and other time-consuming and skilled operations) were no longer preferred. Given the demands of the ever-widening war, the other belligerents would soon turn to the German approach.

This did not happen overnight, as most powers began the war with leftover weapons developed using the traditional method. France had equipped its infantry with the Chatellerault Modèle 24/29. The forts along the Maginot Line were extensively armed with the fortress version of this gun. However, the French had done nothing to replace the 1914 Hotchkiss because they felt that the Maginot fortifications provided an impenetrable defense; in French thinking, the infantry was there "merely to carry out reconnaissance patrols and raids against the enemy as he sat impotently outside the forts."[1] Based on that assumption, the French did not believe that they needed a heavy-support machine gun because fortress guns would always cover the infantry. This assumption soon proved tragically flawed.

Great Britain

The British began the war with the 1912 Vickers as the battalion support weapon and the Bren as the infantry squad automatic weapon, although they still had Lewises left over from World War I. The 15mm Besa, a variant of the 7.9mm Czech ZB vz/53 made under license in Great Britain, eventually replaced the heavy Vickers in armored cars and tanks.

The blitzkrieg that overran Poland in 1939 caused machine-gun production to be stepped up somewhat. However, with the rapid German victories in Norway, Denmark, the Low Countries, and France in the early summer of 1940, various war departments realized huge numbers of machine guns would be necessary to combat German mobility. Britain, which now stood alone, vastly increased

the size of its forces, but the British arms industry could not meet the demands. Thus the British turned to the United States. The Browning caliber .30 M1917, the BAR, and the caliber .50 HMGs were shipped to England. At the same time, large numbers of Lewises and Marlins, mothballed in the United States in 1918, were shipped across the Atlantic for use in the British Home Guard and to arm fishing trawlers and coastal ships against German dive-bombers.

After 1942, there was no further development of machine guns in Great Britain, as the mass production of Vickers, Bren, and Besa guns met their needs. Design revisions were made to all these weapons during the war as shortcomings were identified in combat, but they were the same basic guns that existed before the war.

Given the new tactical approach to warfare, the heavy machine gun, and even the physically heavy medium, which did not fit very well in these tactics, were relegated to a vehicle role. Very few of the millions of heavy machine guns produced during World War II were carried about by infantrymen. Virtually all were assigned to vehicles and aircraft.

With German troops occupying most of Europe, European machine-gun development became a virtual German monopoly until the summer of 1945. The arms factories of France and Belgium, as well as the national arsenals of Denmark, the Netherlands, and Norway, all operated under German supervision. This was also true in Eastern European nations that were occupied by German forces as they moved eastward toward Russia.

Japan

Germany's Axis partner, Japan, showed a surprising amount of development in machine guns during the war. This is understandable given the state of their weapons in 1939. The first new gun to appear was the modified Type 99 LMG. The original version had been redesigned so that it could be quickly dismantled into its major components for use by parachute troops. It passed trials in 1941 and went into production at Nagoya Arsenal.

Next came a redesign of the Type 92 HMG. The original weapon was too heavy, and the IJA demanded a lighter replacement that could be mounted on a sledge similar to the German MG08 mount, capable of being carried by two men. There was internal disagreement about the utility of the sledge mount, and so the project was

tabled in 1940. It was revived in the summer of 1942, and a modified Type 92 was sent for testing. This weapon proved satisfactory and went into production in November 1942 as the 7.7mm Type 1 HMG. It was hoped that the Type 1 would completely replace the Type 92, but Japanese factories never produced enough to supplant the earlier model.

Several other Japanese designs, including a new tank gun, were developed later in the war, but as fighting progressed Japanese manufacturers could not put them into production. With the arrival of U.S. heavy bombers over the Japanese homeland later in the war, industrial capabilities became fewer and fewer.

Soviet Union

The Soviets entered the war with a mix of medium Maxims and light Degtyarevs, with the DShK being produced to replace the Maxims. However, when the Red Army attacked Finland in the 1939 Winter War, its DP and DT machine guns did not operate as well as hoped in the cold environment. They experienced major problems, especially the failure of return springs. Several quick fixes were tried but proved unsatisfactory. Eventually, the spring design and placement were radically changed; the resulting weapons were designated the DP Modernized (DPM). Similar changes were applied to the DT, resulting in the DTM, which was the tank and armored vehicle version.

Other modifications and revisions were made in the early years of the war, including converting them to belt-feed, but this made the DPM too heavy, and the long, flapping ammunition belt was a nuisance to the gunner when sprinting to a new position. It is suspected that the DPM was merely a stopgap pending the development of better weapons.[2]

While production of the DPM continued, the Soviets put engineers to work developing a new 7.62mm LMG. A number of designers, including Vasily Degtyarev, Sergei Simonov, and Mikhail Kalashnikov (his first appearance as a designer; he would later become famous for his assault rifle), participated in this competition. Degtyarev offered two gas-operated guns, one belt-fed and the other with a top-mounted box magazine. Simonov designed a gas-operated weapon. Kalashnikov presented a short-recoil design. The Simonov design was selected after initial trials, but the weapon was neither durable nor accurate.

By the middle of 1943, the Soviets had developed a new short cartridge, the 7.62x39mm, and this led to a rethinking of the LMG concept in the Red Army.

Although the new round had been developed for the assault rifle, it was accurate out to 800 meters, sufficient for the squad light automatic weapon. A call went out for designs using the new cartridge. A number were submitted, and after trials the Degtyarev entry was selected. It was approved in 1944 as the RPD (Ruchnyy Pulyemet Systema Degtyarev—Light Machine Gun by Degtyarev).

The RPD was a derivative of the earlier DP and DPM models but was belt-fed from a drum clipped beneath the gun. For the first time, Soviet infantrymen had a machine gun that they could pick up and use in the assault. Unlike most LMGs, it had a fixed barrel, and the gunner had to be careful to avoid firing more than 100 rounds in one minute to prevent overheating. The war ended before this weapon could be perfected. It would go into full production in 1953 and proved to be a rugged and effective design; it became the standard squad automatic weapon for the Red Army and for Soviet client states.

The Soviets also developed a medium machine gun during World War II. The Degtyarev DS MMG had proved a failure in service, and production was halted in 1941. The Red Army reverted to the Maxim M1910, but when the Germans attacked in OPERATION BARBAROSSA, the supply of machine guns was woefully inadequate. The choices were to build more factories to turn out more of the older model, or to come up with an entirely new design. Pyotr Goryunov had already been working on a medium, and in June 1941 he demonstrated his design to the military. He was instructed to make 50 guns for extensive testing, including some sent to front-line units. The reports were favorable; after some revisions and more tests, it was adopted in May 1943 as the 7.62mm Stankovyi Goryunova 43 (SG43). The SG43 was gas-operated and air-cooled. It was fed by belt and was usually mounted on a wheeled carriage similar to that used with the Maxim 1910. During the Winter War of 1944 against Finland, the SG43 was mounted on a sled for easier movement over snow. It is extremely heavy but was very good for use in the defense. This gun was manufactured in some numbers during the war but never entirely replaced the PM1910, which stayed in production right till war's end and remained in front-line service with the Soviet Army into the 1980s.

The Soviets also used the 12.7mm DShK HMG during World War II. It had originally been employed primarily as an antiaircraft

weapon, but by 1943 it was in wide use in the infantry support role. With the increase in usage, problems with the weapon became apparent; chief among these was a feed problem. Modifications were made to the Shpagin feed system, and various other parts were strengthened, making the gun easier to manufacture, more reliable, and less likely to jam. The new model was designated the DShKM 38/46.

United States

The U.S. Army relied mainly upon two World War I stalwarts, the Browning M1917 water-cooled gun and the Browning M1918 automatic rifle. The M1919 air-cooled machine gun initially went to the cavalry, since they were not expected to have much requirement for laying down sustained fire. This weapon would eventually make its way to the infantry when it was realized that the nature of the war would be one of movement and mobility, not a replay of the 1917 slugfests. The Browning .50-Cal, due to its weight, was initially relegated to an antiaircraft role. As aircraft production increased, most of the .50-Cals produced were going into aircraft.

Due to the excellent design of the Brownings, very few advances or modifications were made during the war. There were some efforts to present new machine gun designs, but none were adopted for service. In 1939, the U.S. Army solicited designs for a machine gun lighter than the M1919 but with more firepower than the BAR. Several manufacturers responded, including Colt, Auto-Ordnance, Springfield Armory, Rock Island Arsenal, and others. A competitive trial was conducted in September 1941. Most of the submissions proved to be little more than revamped Browning M1919s; all were rejected as unsatisfactory. However, one design by William Ruger of Auto-Ordnance had some promise. This weapon, the Light Machine Gun T10, was examined by the Army, but because of pressing matters (e.g., fighting the war), the project was shelved in 1942.

By the middle of 1943, the Army had fought enough battles to know that it needed a good light machine gun, and so the T10 project was resurrected. The original design was completely reworked; the result was the T23, which was gas-operated and belt-fed. It proved to be a success, but by the time it was perfected the M1919A6 modification had already been tried and approved. It was decided that the T23 was not a sufficient improvement over the M1919 to warrant production, so the project was closed down a second time.

The M1919A6 was touted as the fulfillment of all the requirements for a light machine gun, but it is in fact not very light. It is essentially an M1919 modified with a shoulder stock, pistol grip, flash hider, and carrying handle. It weighs 32.5 pounds (by comparison, the Bren weighs 19.3 pounds and the German MG42 25 pounds). Accordingly, the Army was still on the lookout for a true LMG. As the war continued, MG42s had been captured from the Germans and shipped to the United States for testing. The Army was impressed with the weapon and gave the Saginaw Gear division of General Motors a contract to manufacture copies. Saginaw, which had never made a gun before, made a few improvements to the design; the result was the T24 machine gun. However, the design engineers had made a significant error in copying the MG42. They had failed to take into account that the German 7.92 round was shorter than the U.S. .30–06 round. The result was that the bolt did not recoil far enough to permit clean ejection of the case, and the gun was plagued by continual stoppages. Much time and energy was expended on solving the problem before the actual cause was determined. The project was shut down.

In the meantime, a good light machine gun had been privately developed, put into production, and supplied to a combatant nation. Melvin M. Johnson, a lawyer and a U.S. Marine Corps Reserve officer, had begun work in the 1930s on a recoil-operated rifle. By 1941 his model was ready for production. However, by this time the M1 Garand rifle had been adopted, and Johnson's weapon was not sufficiently superior to warrant a changeover. Nevertheless, it was bought by the Marines in some numbers, as well as by the Netherlands East Indies Army (but those weapons were never delivered because the Japanese overran the Dutch) and, eventually, by the Office of Strategic Services. The weapon had drawbacks, and there are accounts of Marines throwing them away in action and using other guns.

At the same time that Johnson had been working on his rifle design, he had also been developing a machine gun, really not much more than a heavy-barreled version of his rifle. He tried to sell it to the Army but was rebuffed because ordnance officials did not like the recoil action and the fact that it was fed from a side-mounted magazine rather than belt-fed. He was able to sell several thousand to the Dutch East Indies Army before the Japanese invasion but delivered only a few before the Dutch demise. The U.S. government stepped in and purchased the weapons he had built; they were given to the Marine Corps.

The Johnson M1941 was a good design. The magazine could be reloaded at any time without removing it from the gun. The gun was capable of semi-auto and automatic fire. Johnson continued to make improvements to the original design, resulting in the Model M1944. Since the United States was happy with the Browning weapons, ubiquitous among the U.S. forces, Johnson found little interest in his design. However, in the postwar years the design was taken by the Israeli Defense Force and modified to feed from a bottom-mounted magazine, becoming the Dror.

MACHINE GUNS IN THE AIR AND AT SEA

Machine guns continued to dominate on the ground, but they also played an important role on the seas and in the air. As aircraft began to develop during the interwar years, many improvements were made to the crude armament that was affixed to the first generation of combat aircraft. The improved reliability of machine guns meant they could be mounted in the wings' leading edges, allowing for more room compared to the original fuselage mounts. With the development of high-speed pursuit aircraft, machine guns became the primary means by which enemy aircraft could be shot down during aerial combat. British aircraft were originally armed with Vickers guns, but as World War II approached most were replaced with M2 Brownings, preferred because of their higher rate of fire and slimmer profile. For example, the Supermarine Spitfire—the legendary British fighter sporting distinctive elliptical wings—was armed with quad .303-inch M2 Brownings in each wing in the Mark I form. Machine guns in flexible mounts also played an important role in the self-defense of heavy bombers like the B-17 Flying Fortress and B-24 Liberator, which carried as many as 14 .50-Cals mounted in strategic areas throughout the fuselage. The light attack bombers, like the Douglas A-26 Invader and the B-25 Mitchell, packed more than a dozen machine guns each using a variety of fixed and flexible mounts.

Ironically, the old Vickers guns played a significant role in the air forces of one of the Allies' opponents. The air forces of Japan (within the army and navy) had acquired 2,000 Vickers guns by 1937, then began domestic production as the Type 89 (army) at the Kokura Arsenal and Type 97 (navy) at the Yokosuka Naval Arsenal and at KK Nippon Seikosho. The Type 97 was fitted into the most famous Jap-

anese aircraft of the war: the Mitsubishi Zero. The Imperial Japanese Navy also used the gas-operated Vickers as light antiaircraft guns aboard ships.

The Japanese were obviously not the only ones to employ machine guns on ships and vessels. Light machine guns provided excellent antiaircraft defense on merchant ships. Machine guns also played an important role in all types of warships, from aircraft carriers to torpedo boats to submarines. Mounted in singles, pairs, fours, or eights, machine guns were an important component of the short-range defensive armament of vessels of all kinds.

CONCLUSION

Ian V. Hogg suggests that is "perhaps surprising that there was so little development of machine guns during the war years, but a moment's reflection will reveal the reasons."[3] He points out that most of the combatants had settled on their standard-issue machine gun before war broke out. Therefore, most of the work during the war was on modifying proven designs to make them quicker and easier to manufacture or to take care of some defect in an original design. The machine gun was an integral part of combat during World War II on the ground, in the air, and at sea.

NOTES

1. Ian V. Hogg, *Machine Guns: 14th Century to Present* (Iola, WI: Krause Publications, 2002), p. 144.
2. John Walter, *Modern Machine-Guns* (London: Greenhill Books, 2000), p. 126.
3. Hogg, *Machine Guns*, p. 169.

CHAPTER 8

The Cold War and the Future

With World War II over, there was a momentary hope that peace had returned to world affairs. This proved to be only a momentary respite. The Cold War began almost immediately as West and East settled in for a 50-year confrontation marked by wars and armed conflicts. Many of the machine guns and submachine guns used during World War II and developed thereafter were utilized.

POSTWAR DESIGNS

New automatic designs were under development at the end of World War II. With the exception of Germany and Austria, virtually every European nation continued to produce new weapons, particularly submachine guns, at a surprising rate. In the period 1945–1960, submachine gun designs were developed in response to a call from armies around the world. The weapon was attractive because it had proved itself during the previous war and was relatively simple to make.

New SMGs

In Britain, the Sten SMG slowly gave way to the Machine Carbine, 9mm L2A1, known as the Sterling. The Sterling appeared simple

but was better-made than most contemporaries, with a higher proportion of machined parts. It proved reliable, particularly in adverse conditions. There was a silenced version, the L34A1, for special operations use and also a police version. The magazine was side-mounted. Unloaded it weighed only 6 pounds. The Sterling went into service with the British Army in 1953 and completely replaced the Sten by the early 1960s. It was also exported in large numbers.

The submachine gun found a new role in the unconventional conflicts of the Cold War. A number of the World War II–vintage SMGs, like the Thompson and the PPSh-41, saw service in Korea, Vietnam, and other conflicts around the world. Concurrently, new submachine guns appeared on the market. The French armed themselves with the MAT49 during both the disastrous First Indochina War and the Algerian War. The Australians developed the Owen F1, a modification of an earlier design that proved to be rugged and reliable during Australia's participation in Vietnam and elsewhere. The Czechs and the Italians each produced submachine guns during this period that were sold to smaller nations. Even Germany and Austria produced new models, with Hechler & Koch, Steyr, and Walther each developing SMG designs.

It was also during this period that U.S. designer Gordon Ingram produced his first submachine gun. The M6 was made in two versions, chambered for the 9mm Parabellum and caliber .45 cartridges. However, possibly the most unique postwar SMG came from a very unlikely source. Uziel Gal, a former freedom fighter who became a major in the Israeli Defense Force, designed a new machine pistol that would eventually become world-famous. The Uzi was a short weapon with the magazine mounted within the pistol grip; it was well-balanced and could be fired with one hand if necessary. The Uzi was not an instant success outside Israel when it came on the market in 1950, but it soon earned a reputation as an accurate, reliable weapon and was eventually adopted by countries for use by armed forces and special-forces operations. In 1984, a miniaturized version, the short-barreled Mini-Uzi (which was less than 10 inches long), was released.

Ultimately, in the post–war years most armies would turn to assault rifles as the mainstays of their military forces. Although there was still a role for the submachine gun to play in special operations, it appeared that the days of the submachine gun were numbered with the general adoption of small-caliber ammunition such as the 5.56mm and the like. Thus new assault rifles would supplant the

submachine gun as more and more armies discarded them in favor of the small-caliber rifle. However, with the rise of terrorism and the fact that organized criminal elements were quick to adopt automatic weapons, police forces began to improve their arsenals; the submachine gun answered this need. It is convenient to carry, holds plenty of ammunition, can be fired from the shoulder (giving better accuracy than a pistol), and fires a short-range bullet that is less likely to ricochet off a wall and kill an innocent bystander. This demand in police forces worldwide added new impetus to the development of submachine guns. In response, Heckler & Koch (HK) produced the MP5. A highly accurate weapon in the hand of a skilled user, the gun is favored by special forces and hostage-rescue teams. The Italians developed the Spectre, a unique design that incorporated the same double-action trigger mechanism of the revolver, thus negating the need to cock the weapon before it can be fired—one of the old drawbacks of the SMG.

The Soviets also produced a submachine gun during the 1980s. Firing their 5.45mm rifle cartridge, the AKS was a departure from the normal practice of using pistol ammunition. Soviet designers ran into the same problem when using larger cartridges; the barrels of most submachine guns were too short to burn all the larger cartridge's propellant before the bullet left the muzzle. Rifle and machine-gun barrels are normally long enough for the propellant to burn well within the barrel, permitting the bullet to stabilize before leaving the muzzle. With short barrels, however, the powder in larger cartridges burns fully only after the bullet leaves the muzzle, leading to a bright powder flash and inaccuracy. The Soviets tried to overcome this in the 5.45mm AKS with an expansion chamber to stabilize gases. The AKS was first seen in Afghanistan in 1983.

The development of the assault rifle nearly meant the demise of the submachine gun except for special purposes. However, two factors changed the direction of this trend. First, given the expense of arming forces with assault rifles and sophisticated machine guns, armies began to reconsider whether every soldier needed to be outfitted thus. As Ian Hogg points out, about four-fifths of the personnel of an army do not need an assault rifle because their duties are noncombat.[1] Therefore, it was illogical to give them an expensive weapon. However, they still need to protect themselves if worse comes to worst. The pistol was not the answer, and the traditional submachine gun was fast becoming obsolete. Second was the technological improvements to personal body armor, which had become more commonplace. Most body armor was

designed to defeat pistol rounds and thus could stop most submachine-gun rounds. Fabrique National (FN) of Belgium looked at these problems and came up with the P90 SMG, a futuristic design that fires a 5.7mm bullet at high velocity that can defeat body armor. The Belgians described this gun as the Personal Defense Weapon, or PDW. Several other arms designers are now working on their own versions of the PDW. Although SMG development has been somewhat disjointed since World War II, the weapon is still with us. The emergence of the PDW concept may breathe new life into the submachine gun.

MMGs and HMGs

The situation for mediums and heavys in the postwar years was similar to that at the end of WWI, as there were many such weapons left over from the war. For the Allies, they proved to be winners, and in the early years following World War II there was a strong feeling of "if it isn't broken, don't fix it."[2] However, there was eventually a realization that these weapons were getting a bit long in the tooth; it was time to pursue new designs.

Ironically, many designers looked at the losers of World War II for inspiration. During the war, the Germans had gained success on the battlefield with a machine gun that could be employed in a variety of roles. The MG42 GPMG was the epitome of this policy. As Ian Hogg points out, "It was carried over the soldier's shoulder as the squad automatic, mounted alongside tank guns as coaxial weapon, fitted on to vehicle roofs and tank turrets as protection and air defense gun, mounted on a tripod for sustained fire, locked onto a frame for firing on fixed lines." Put simply, "Whatever you wanted to do with a machine gun, the MG42 could do it."[3]

GPMGs

With the MG42, the Germans were ahead of their time in the development of the GPMG. In the immediate postwar years, both military leaders and weapons designers studied the lessons of the war. With regard to machine guns, it was soon almost universally agreed that the German approach—having one machine gun capable of

multiple roles rather than manufacturing and maintaining various specialized models—was the best tack. Doing so meant that there would be one model to manufacture, one model to train with, and one model that needed spare parts and ammunition. Based upon that realization, there was a rush toward the GPMG.

NATO

The problem was that no nation, save Germany, had a gun that met GPMG requirements. That meant that such weapons had to be developed from scratch. This effort was given additional motivation with the formation of the North Atlantic Treaty Organization (NATO) and the need for a standardized small-arms cartridge. The British went ahead and developed the Taden or XE5 GPMG, which was a decent design. However, it fired a short 7mm cartridge developed by the British. This was unacceptable to the Americans, and after some heated debate among NATO members the 7.62x51mm round was accepted as the standard NATO cartridge.

FN–MAG

By the time that the issue of standard ammunition was settled in 1954, the Herstal-lez-Liege factory of Fabrique National of Belgium had already taken a calculated risk and developed a GPMG using this cartridge. When the NATO decision was made, FN was already prepared to market its weapon. The Belgian weapon was the FN Mitrailleuse d'Appui Generale (General Purpose Machine Gun, or MAG). It is gas-operated and belt-fed. Weighing in at a fraction over 22 pounds, it could be fitted with a butt and bipod for use as the squad automatic weapon or with spade grips and a tripod for use as the company support machine gun. It could also be mounted in armored vehicles and on boats, and in later years it would appear in helicopters and aircraft. The FN–MAG is arguably one of the best machine guns ever made, and the British adopted it in 1957 as the L7 General Purpose Machine Gun. It proved very effective during the Falklands War in 1982. The FN–MAG would eventually be adopted by more than 75 countries, most of which had already adopted the FN FAL rifle, usually in 7.62mm NATO caliber (even though many of these countries were not NATO members).

West Germany

When West Germany was allowed to rebuild its armed forces, the Bundeswehr (the postwar army) was initially provided with U.S. weapons. However, the Germans, with their own ideas about weaponry, wanted to develop an indigenous GPMG. The obvious answer was to look at the MG42, but during the chaos that marked the end of the war the original engineering plans disappeared. The only way to recapture the design was to acquire a weapon, take it apart, and reverse-engineer it, making a fresh set of manufacturing drawings and specifications.

From these specifications grew the MG1, which was only slightly different from the MG42. It was developed by Rheinmetall in 1959. Originally chambered for the 7.92mm Mauser round, it was rechambered for the 7.62x51mm NATO cartridge, which changed the designation to MG1A1. The MG1A1 uses a continuous metal link belt known as the DM1. Later it was modified to take the standard U.S. Army M13 linked ammunition belt; this changed the designation to the MG1A2. The design went through several other modifications until the final version, which is significantly different from earlier versions and redesignated the MG3. The MG3 was subsequently adopted by Austria, Chile, Denmark, Greece, Iran, Norway, Pakistan, Portugal, Spain, Sudan, and Turkey. They have been built under license in Greece, Iran, Italy, Pakistan, Spain, and Turkey.

Heckler & Koch also designed and manufactured a GPMG for export. Derived from the highly successful HKG3 rifle, the HK21 relied on the blowback system of operation and was belt-fed with an interchangeable barrel. The HK21 was unique: by changing the barrel, bolt, and parts of the feed mechanism, the gun could be converted to fire 7.62x39mm Soviet or 5.56mm NATO cartridges. This feature was later dropped due to lack of demand from buyers. The HK21 was followed in the 1970s by the HK21A and ultimately the HK21E. Although the HK21A and 21E were never adopted by the German Army, they were sold successfully in the export market.

France

The French developed their own GPMG in the form of the Arme Automatique Transformable 52 (AAT 52). It was arguably the first GPMG developed in the postwar years, and one might assume that

it received serious consideration for adoption by other NATO armies during the 1950s. However, two features of the weapon mitigated against that. First, it is chambered for the 7.5x54mm Modèle 1929 French cartridge, and the French showed little interest in changing it to handle the standard NATO cartridge. Second, it employs a delayed-blowback design, a principle of operation that most armies viewed with suspicion given the problems incurred when using it with a high-power rifle cartridge. Despite the fact that it was not adopted by any other nation, the French have stuck with it for nearly a half-century. However, in the late 1960s they finally adopted the 7.62x51mm NATO cartridge and modified the gun accordingly, changing the designation to AA52 F1.

United States

The United States had been contemplating the development of a GPMG since before the end of World War II. In fact, work had begun in 1944 on a design called the T44, based almost entirely on various aspects of existing German weapons. The belt-feed system was copied from the MG42, the piston and bolt system from the FG42 paratroop rifle. Ultimately, the design proved a failure, but it did provide good lessons that were incorporated into subsequent GPMG development efforts. A follow-on design resulted in the T52, which had a modified piston and bolt, but with the end of the war the effort slowed. Nevertheless, a few changes were made to the T52, which was then designated the T161.

The war in Korea demonstrated that the BAR and the Browning M1919A4 were still sound weapons, but they were not suited to the modern tactics that evolved, which put a premium on lightly equipped infantry soldiers in airmobile operations. Therefore, efforts were renewed to find a new machine gun to replace both the BAR and the Browning LMG.

With the adoption of the 7.62x51mm NATO cartridge and the M14 rifle, the U.S. Army modified the T161, also chambered for the NATO round. The modified weapon became the M60 GPMG. The M60 was built using steel pressings and plastic components and is the first U.S. machine gun to use a quick-change barrel. It could be used as either a squad weapon with a bipod, or for company support as a sustained-fire gun with a tripod. It replaced the M1917 and M1919 families of machine gun and the BAR as well as the Thompson SMG and the M3 (Grease Gun) SMG.[4]

The M60 is a gas-operated weapon with a rotating-bolt locking system. It fires ammunition on a disintegrating link belt. It fires 550 rounds per minute and has a maximum effective range of 850 yards on a bipod and more than 2,000 yards on a tripod.

The first M60 model had serious faults, which were soon identified and corrected. The weapon was being used in combat in Vietnam, which ensured that the problem areas were quickly noted and the required modifications made rapidly. The most notable difficulty was that the interchangeable barrel formed a single unit with the gas cylinder and bipod. This was a heavy unit and meant that when the gunner changed the barrel he had to either set the hot gun on the ground or support it with his hands until an assistant fitted the new barrel. This was cured with the issue of the M60E1, which attached the cylinder and bipod to the gun body, simplifying the barrel-changing and improving the belt-feed system. Eventually, the M60 was modified for additional roles: the M60C would be developed as an outboard gun for armed helicopters, and the M60D would be used as the standard door gun. The M60E2 was designed for internal mounting in armored vehicles. In every case, the M60 was a very effective machine gun that proved itself time and again in intense combat in the jungles of Vietnam, where it seemed to be everywhere. It was the mainstay of the infantry as they humped through the jungles, it was mounted on armored personnel carriers, and it served as the door gun for assault helicopters and in flexible remote-controlled mounts on attack helicopters. The M60 has served with distinction in every conflict since and remains the GPMG of choice for the U.S. Army.

Saco Defense Company developed several M60 models, including the M60E3 and the M60E4, which are lighter and have forward pistol grips. Unlike the original M60 models, the Saco models have adjustable foresights. These two versions have been put into service by the U.S. Marines, Navy, and Air Force. The M60 was provided to U.S. client states like South Korea, South Vietnam, and Taiwan. Australia also procured small numbers of the weapon.

Soviet Union

While many countries adopted the FN MAG, the MG3, the AA 52, or the M60, it seems that many of the rest have adopted a GPMG of Russian design. At first, the Soviets were unconvinced by the concept of one gun for all roles. They were content with the RPD

LMG, which began production in 1944. After the war, the Soviets and their satellites continued to produce and use the RPD. However, by the mid-1950s the Kalashnikov AK47 was completely replacing the older Simonov service rifle. Soviet armament officials wanted to develop a light machine gun from the Kalashnikov design that would simplify soldiers' training as well as ammunition requirements. Kalashnikov responded by simply putting a longer and heavier barrel, a larger magazine, and a bipod on his basic rifle to form the RPK; with a distinctive hooked stock, it was probably introduced around 1962 and was first spotted by Westerners in 1966, by which time it had largely replaced the belt-fed RPD in Soviet rifle squads.

The RPK was fed from a curved, 40-round magazine, but there was also a 75-round drum that could be clipped into the same feed access. In an emergency, the standard 30-round AK magazine could be used. There are normally two RPKs in a Russian rifle squad. Sharing the good and bad points of the AK, the RPK is light, tough, and simple to use. The RPK was later modified into the RPKS, the same gun but with a folding butt for airborne and special forces. It was also adopted widely by satellite armies and was sold to many otherwise uncommitted countries.

The main advantage of the RPK and its derivatives is the commonality of parts with the AK and AKM rifles. The bolt from an AK rifle will work in an RPK. The RPK is provided with two magazines, a box holding 40 rounds, and a drum holding 75 rounds; as previously stated it will also accept magazines from AK and AKM rifles.

As the original RPD approached obsolescence, the Soviets at least partially accepted the general-purpose approach with the adoption of the Pulemyet Kalashnikova (PK), known as a unified machine gun in the Russian lexicon. The PK, which is gas-operated and uses a rotating bolt, was designed by Mikhail Kalashnikov, drawing heavily on earlier designs such as the RPD and AK47. Additionally, the barrel-changing system and much of the feed system comes from the SGM; the piston operation is derived from the Czech vz/52, the trigger mechanism from the RPD. The result is a reliable weapon that is light, simple to maintain, and has very little recoil and muzzle jump when firing.

The PK, adopted by the Soviet Army in 1961, is the basic gun in a family of similar weapons. The PKS is the PK mounted on a tripod that is suited for sustained support fire and can be extended to serve in the antiaircraft mode. The PKT is a variant adapted for use as a coaxial machine gun in tanks. The PKM is an improved version of

the PK with a lighter barrel, bringing the weight down to about 18.5 pounds.

During the Cold War, the Soviets also had a heavy machine gun, but it was really a 1946 update of the DShKM. This weapon, known as the Duska to Russian soldiers, was used by infantry units on wheeled or tripod mounts; like the Browning M2, they were also mounted on tanks and armored vehicles to provide defensive fire against ground troops and aircraft. The performance of the DShKM is similar to that of the M2, but it fires a slightly lighter round at a slightly lower velocity. The Duska was used very effectively by the Vietcong and North Vietnamese troops in the antiaircraft role against helicopters and low-flying aircraft. The DShKM was mounted on almost all Russian-designed tanks, and they were used by both sides during the Soviet war in Afghanistan (1979–1989). Although the Russian weapon is no longer manufactured, it can still be found in the armies of the former Soviet Union and most former client states.

China

As for the other major power in the communist bloc, the People's Republic of China, there were no major innovations given that most of their weapons were copies from other designers. For example, the Chinese Type 67, a "native" design, was really an amalgamation of design copies. It was belt-fed and gas-operated; the feed system was borrowed from the Maxim, the bolt and gas piston from the Czech ZB 26, the trigger mechanism from the Russian Degtyarev DPM, the gas regulator from the RPD, and the barrel-changing system from the SGM. After these components were brought together, revisions and modifications were made to include a slightly heavier barrel, a 250-round belt box, and a new tripod. This weapon became the standard GPMG for the Chinese Army in the early 1970s until it was replaced by the Type 80, which was no more than a Russian PK made in China. Large numbers of the earlier-model guns were supplied to the Vietcong and to the North Vietnamese Army.

The Chinese also adopted and copied another Soviet weapon as their light machine gun. A Russian engineer named Shilin had modified the Degtyarev DP with a slightly heavier barrel and an improved belt-feed system. It passed trials in the Soviet Union and was adopted as the Rotnyy Pulyemet 46 (Company Machine Gun; RP 46). Although it was adopted by the Soviets, it was never put into

service in the Red Army. Most appear to have been disposed to Soviet client states. The Chinese adopted it as the Type 58 and later manufactured it in China. The North Koreans called it the Type 64 and also manufactured their own.

THE RESURGENCE OF THE LMG

Elsewhere the LMG idea was not totally abandoned. It had found a niche during World War II, but with the popularity of the GPMG after the war its days seemed numbered. Few armies went entirely with the GPMG approach.

Great Britain

The British in the late 1940s wanted a light machine gun to accompany the EM2 bullpup-style rifle, a unique design in which the magazine, breech, and bolt mechanisms were behind the grip and trigger, with the butt becoming an extension of the body. Accordingly they developed the EM2 LMG in .280 caliber. It was simply a heavy-barreled EM2 rifle with a bipod. With the adoption of the standard NATO round both weapons became obsolete, and the British turned to the FN-MAG in the form of the L7A2 GPMG.

Czechoslovakia

There were other entries in the postwar LMG category. The Czech Army adopted the vz/52 LMG in the early 1950s. It was a unique weapon with interesting features. It was fed from belts or box magazines without the need for special adapters. The gunner merely opened the feed cover and either put a belt in place across the feed platform or pushed a box magazine into the aperture in the feed platform. Cocking the weapon was accomplished by pushing the pistol grip and trigger unit forward and then pulling it back to cock the bolt. Semi-auto fire was achieved by pulling on the top section of the trigger, automatic fire by pulling on the bottom section. Changing the barrel was quickly performed by opening the feed cover or removing the magazine if fitted, then rotating the feed cover to the right until the barrel was freed; it could then be pulled

forward by the carrying handle. Perhaps the most unique thing about the vz/52 was the flash hider on the muzzle. It was conical and pierced with several holes. The mouth of the cone narrowed, leaving just enough space to allow the bullet to pass through. The general effect was to act as a muzzle brake and cut down on recoil. The gases inside the cone were forced out sideways, as the emerging bullet briefly blocked the exit hole. The result was that when fired at night there was often a halo of flame around the flash hider. Despite its features, the vz/52 and its successor, the vz/52/57 did not survive for long. Ultimately, the Czechs decided to go with the vz/59 GPMG rather than a new light machine gun.

Israel

The Israelis developed the Galil 7.62mm Assault Rifle/Machine Gun (ARM) model, which appeared in the early 1980s. This is a heavy-barreled version of the Galil 7.62 rifle, which some have characterized as a thinly disguised copy of the Kalashnikov AK47.[5] The result is that the ARM looks like little more than an RPKS with a shorter barrel and carrying handle.

South Africa

South Africa is a special case, as it was subjected, due to its policy of apartheid, to an international boycott, during which it could not obtain arms from other countries. Therefore, a thriving and highly efficient South African arms industry developed out of sheer necessity. They produced a gas-operated, air-cooled, belt-fed machine gun, the Vektor SS-77. First designed in 1977 by South African engineers Smith and Soregi, the project was shelved until 1984. The first guns went into service in the South African Army in 1986.

South America

In South America, most countries relied on Europe for small arms. World War II changed all that, and some turned to the United States for weapons, but the U.S. entry into the war caused that source to dry up. After the war, access to European armament companies resumed, but most South American governments turned to

license agreements with European firms to build weapons at home. A good example can be seen in the agreements with FN for the production of the FN-FAL rifle and MAG machine guns. In the 1970s, several South American companies began producing their own designs. The most prominent was the Brazilian Uirapuru GPMG, which appeared in the late 1970s. Initially there were problems with the design, and several modifications were made. It was not until the late 1980s that the gun was approved for production and issue and offered for sale.

MICROCALIBERS AND SAWs

In the 1960s, a new wrinkle in machine-gun development arrived when the 5.56mm cartridge was introduced and was then adopted by NATO in the late 1970s. The change to lighter ammunition meant that designers could pack the firepower of a belt-fed weapon into a lighter, handier package.

Microcalibers

The result was the development of automatic weapons in the *microcaliber* category. Driving this effort was the typical idea that a light machine gun for rifle squads should be in the same caliber as the soldiers' rifles, thus permitting riflemen to feed the machine gun (or vice versa) in times of need. There were two ways to achieve this. One could take an existing machine gun and scale it down to fit the smaller ammunition. Alternatively, any existing 5.56mm semiautomatic rifle could be turned into a machine gun by giving it a heavier barrel, a larger magazine, and a bipod. Several manufacturers tried such approaches but met difficulty. As Ian Hogg has pointed out, "There seemed to be some crucial point at which muzzle velocity, rate of fire, caliber and temperature all came together to produce a phenomenal rate of wear in these small-caliber barrels."[6] Infantrymen were less than excited about a weapon that needed a replacement barrel after only a few thousand rounds. Eventually, however, engineers were able to determine the optimum rate of fire, velocity, tolerances in bullet and bore diameter, and other factors so that a viable machine gun could be produced.

Once the solutions were worked out, both techniques were used

to produce microcalibers. Heckler & Koch first developed its HK33 rifle in 1965 and followed it with their HK13 5.56mm machine gun. The HK13 was little more than the rifle with a quick-change heavy barrel, a bipod, and a larger magazine. The HK13 was a good design, but it was not made in great numbers because at the time of its introduction in 1965, most armies had not even contemplated changing over rifles, let alone machine guns, to caliber 5.56mm. Thus it was ahead of its time and seen as something of an oddity.

There were several other early efforts in this area. One was the Steyr-Mannlicher (SM) AUG Light Support Weapon, perhaps the most successful of the first-generation 5.56mm machine guns. It was simply an SM AUG rifle with a heavy barrel, a bipod, and a 40-round magazine. Another was the Stoner 63 machine gun, which appeared in 1965. It was a heavy-barreled variant of the 5.56mm Stoner rifle, invented by Eugene Stoner, the designer of the M16 rifle. The Stoner was a unique design and was actually a weapons system rather than a simple LMG. By changing barrels and other components, the gunner can configure it into a variety of forms, from assault carbine to company-support machine gun. It was used in limited numbers by U.S. Navy SEALs during Vietnam.

It was not until the early 1980s that the 5.56mm microcaliber began to make headway. At that time, three designs appeared, just as armies were beginning to reconsider lightweight weapons. One of the earliest was the German HK23, a 7.62mm HK21 with some components changed to fit the smaller caliber. This gun had a folding bipod and front handgrip. It provided a relatively light weapon at just over 19 pounds yet provided the squad with excellent firepower.

Without a doubt, the most popular of the new squad automatic weapons was the Minimi developed by Fabrique Nationale of Belgium. The Minimi was under development in the mid-1960s. The first prototypes were fired in 1974, and the weapon was put into production in 1982. The mechanism was put through a long period of testing before it was marketed, and it was quickly adopted by several major armies. It has unique features. There has been a long-standing argument among militaries about whether the squad automatic weapon should be fed from a magazine or from a belt. The Minimi is capable of both. A standard M16 rifle magazine can be inserted obliquely from the lower left side; alternatively it can be loaded with a 200-round disintegrating link belt. The weapon has a variable rate of fire depending on whether it is magazine-fed or belt-fed. With the magazine the weapon is capable of firing 1,000 rounds per minute; belt-fed, it fires 700 rounds per minute. It has a quick-

change barrel and is normally provided with a bipod, but it can also be mounted on a tripod. Fixed or folding stocks are available, as is the short-barreled paratrooper model.

SAWs

The U.S. Army had been in a market for a squad automatic weapon (SAW) system since the mid-1960s, when it was decided that a machine gun lighter and more portable than the M60 would be an advantage. A number of weapons had been designed, built in prototype, and tested thoroughly, but none were adopted. When the selective-fire M16 rifle was adopted, it was thought that the need for a light machine gun was no longer pressing. However, after testing the M16 in the LMG mode, it was deemed unsuitable as a SAW, and design proposals for a new LMG were solicited in 1969. The specifications included a weight of not more than 22 pounds with 200 rounds of ammunition and an effective range of 800 yards. One problem was that the 5.56mm cartridge had not yet been universally accepted in the U.S. Army.

Because of the questions surrounding 5.56mm ammunition, two designs were not even considered for the new light machine gun. The Stoner 63, previously mentioned, was a versatile weapon, but it used the 5.56mm cartridge. The other weapon, the Colt CMG-1, was little more than a heavy-barreled version of the M16 rifle. In addition to using the questionable 5.56mm cartridge, it also was magazine-fed. Traditionally in the U.S. Army, belt-fed machine guns were preferred (excepting the BAR). Colt made some modifications, and the result was the CMG-2, which is belt-fed from a drumlike belt carrier located beneath the receiver. It is a reasonable design, but to give it better down-range stability Colt chambered it for a special 5.56mm cartridge that was heavier than the standard 5.56mm cartridge. This feature undercut the objective of the SAW because nobody wanted to produce an entirely different 5.56mm cartridge solely for the new machine gun. However, after designers and U.S. ordnance staff looked at the problem, they concluded that a heavier bullet was needed. The result was the 6x45mm round, which is heavier than the standard 5.56mm rifle. With higher muzzle energy, it was able to maintain velocity downrange while outranging the standard round, as well as being more lethal.

With the ammunition issue settled, designs were submitted to the U.S. Army for consideration. Eventually the field was pared down to

six major players: FN of Belgium, Heckler & Koch of Germany, and from the United States Colt, Maremount, Philco-Ford, and the Rodman Laboratory of Rock Island Arsenal. Field trials were completed in 1974.

The FN submission was the design that was later perfected as the Minimi. The Heckler & Koch candidate was the HK23. Both were caliber 5.56mm weapons. It was assumed that if either was successful, then the design would be modified to handle 6mm ammunition.

The Colt entry was a heavy-barreled M16 generally similar to the CMG-1 but in caliber 6mm. The Maremount design, based upon an earlier private venture known as the Universal Machine Gun, was the XM233, a gas-operated machine gun fed from a belt drum. The Philco-Ford submission was the XM234, also belt-fed and gas-operated. The Rock Island design, the Rodman XM235, was a bullpup, which means that the end of the receiver rests on the gunner's shoulder and his face is alongside the action. During the early 1970s, this was a radical design viewed with suspicion in many quarters.

The HK23 and the M16 failed the safety tests. The other four weapons completed the trials, and a detailed report was compiled on the findings. The Department of the Army changed directions again, deciding that the 6mm cartridge was impractical due to the increased logistical and supply problems that it would entail. Therefore, it was decided that any future infantry weapon developments would have to use either the standard NATO 7.62mm or 5.56mm rounds. This decision brought the 6mm SAW system program to a screeching halt. What ensued was a series of contentious issues over ammunition, funding, and specifications. After much debate, the FN Minimi was finally accepted by the U.S. Army as the M249 LMG in 1990. The Minimi has also been adopted by many other countries, including Italy, Australia, Belgium, Canada, and Indonesia.

A number of other SAWs have been developed. CETME in Spain produced the Ameli, another 5.56mm weapon that looks like a scaled-down MG42 or MG3. First seen in 1982, the gun is light, compact, and fires the NATO 5.56mm cartridge from a disintegrating belt. A 100- or 200-round plastic belt box can be attached beneath the receiver. It is in service with the Spanish Army as the standard squad fire-support weapon.

Chartered Industries of Singapore developed the Ultimax 100, which is extremely light at just over 10 pounds. It is designed to be operated by one man and fires 5.56mm NATO ammunition from a

100-round drum. The weapon appears to be too light and fragile to be an effective battlefield machine gun, but the manufacturer's trials proved its capability to withstand sustained fire and rough handling. To date, this light and effective weapon is in service only in Singapore.

The Israelis also developed their own SAW. The Negev 5.56mm is close in concept to the Minimi, weighing only 16 pounds. The designers built the weapon to be as flexible as possible, and it will feed from Galil or M16 box magazines, drum magazines, or continuous belts. The magazine feed is from below, and in this way the gun becomes a heavy assault rifle. A metal disintegrating link belt may be fed in from the left side of the receiver's top cover. Instead of clipping a plastic belt box beneath the gun, the Israelis use an unusual zippered, drum-shaped, canvas bag to hold a 200-round belt. This permits the soldier to move stealthily without the sound of rattling ammunition. In service only in Israel, the Negev provides a tough and reliable weapon for rifle squads.

THE GATLING AND MINIGUN

One innovation in machine-gun development during the Cold War and later years involved returning to the idea of the Gatling gun. In the first years after World War II, the fledgling U.S. Air Force identified a need for an aircraft-mounted machine gun with a high firing rate. After considering different types of weapons, it was decided that the basic principles of the Gatling system offered the greatest potential for a modern aircraft weapon. This was due to the tremendous rate of fire and the reliability of the design, incorporating a rotating cluster of barrels powered by an external source. This approach reduced the heat normally generated in high–cyclic rate guns and permitted cooler, more reliable operation. The only difference between the modern Gatling gun and the original was that the latter used percussion caps, whereas the new weapon employed electric ignition. The external power source permits each round to be fired independently of the previous cartridge; thus, any duds are automatically ejected and a faulty cartridge will not stop the gun. This is a substantial advantage over gas-operated weapons, which are subject to jamming if a round does not fire, a situation that Ian Hogg describes as "a trifle embarrassing to the pilot in the middle of a dog-fight."[7]

Vulcan

With this in mind, the Armament Systems Division of General Electric (GE) was awarded the contract for PROJECT VULCAN in June 1945. The development effort was a joint venture between GE, the U.S. Air Force, and U.S. Army Ordnance. The first prototype, designated the T-45, was completed in April 1949. The weapon was produced in three versions: caliber .60, 20mm, and 27mm. All versions were tested intensively at the Springfield Armory and Aberdeen Proving Ground; the 20mm was selected for further refinement. After refinements were made, the weapon was accepted as the M61, 20mm, Vulcan Aircraft Gun and ordered into production in 1956.

This weapon has six barrels locked into a rotor assembly. Pressing the firing button causes the barrel cluster to rotate counterclockwise, firing each barrel in succession from a container of linked rounds fed through a plastic chute running up to the gun. The M61 is powered by a drive motor—either electric, hydraulic, or ram-air turbine, depending on the type of aircraft in which the gun is mounted. The weapon can fire ball, armor-piercing incendiary, or high-explosive incendiary ammunition. The M61 20mm Vulcan formed the basis of an entire new family of super-fast, external-powered machine guns in everything from caliber 5.56mm to caliber 30mm.

The M61 was installed on different aircraft, including fighters and bombers. It went into service with the U.S. Air Force on the F-104 Starfighter. Eventually an M61 gun pod was developed to provide a self-contained unit that could be slung under the wing of high-performance close air support aircraft for engaging ground targets. The Navy and the Army also purchased the M61. The army adopted it as the M168 to form the basis for both a towed and a vehicle-mounted air-defense system. The M61 was also modified to produce a three-barrel version, the M197, which was tailored for U.S. Army and Marine use in Cobra attack helicopters and for the U.S. Air force in fixed-wing gunships. The Navy commissioned GE to build the autonomous Phalanx close-in weapon system around the Minigun, designed to defend ships against missile attacks at short range.

Minigun

The M61 further evolved into the GAU-2B Aircraft Machine Gun (Mini-gun) in 1960 when GE engineers applied the design to a sim-

ilar gun in rifle caliber. The basic Vulcan mechanism was simplified and redesigned to fire the 7.62mm NATO round. The first prototype was tested in 1964. The result was a fast-firing, lightweight armament package for helicopters and other light aircraft, where a very high rate of fire was needed against personnel and unarmored vehicles. It was capable of firing up to 6,000 rounds per minute. It could also be easily modified by changes in the feeder, housing, bolts, and barrels to fire the 5.56mm round as well. Like their bigger brother, the smaller-caliber versions were also produced in a pod configuration (designated SUU-11) that could be slung beneath the wings of aircraft or on the undercarriage of helicopters.

The first combat operations of the GAU-2B Mini-gun saw them mounted transversally inside the fuselage of the C-47 Dakota, an antiquated cargo plane that had been modified to serve as a gun platform in Vietnam. The guns fired out what had originally been the aftmost cabin windows and the cargo door while the pilot flew a tight pylon turn around a ground target below (basically, flying in a circular pattern so that the gun could pour fire continuously into a small area). These aircraft became known as Spooky or Puff the Magic Dragon and proved to be very effective ground-attack aircraft. The concept was expanded, first into the Shadow and Stinger, and ultimately into the AC-130 Spectre, which was initially armed with four miniguns, two of which were later removed and replaced by a pair of 40mm Bofors guns and, in the Pave Aegis model, by one Bofors and a specially adapted M102 105mm howitzer.

Cannon Variants

GE extended the M61 concept to fill the gap between the 7.62mm minigun and the 20mm rotary cannon. The result was the caliber .50 GAU-6. The original intent was to use this weapon as a test bed to produce a gun chambered for a new 10mm round to be developed simultaneously. The new round never panned out, but the GECAL 50, as the GAU-6 was known, appeared in two models: a six-barreled gun firing up to 8,000 rounds per minute, and a three-barreled version that fired 4,000 rounds per minute. Mounts for helicopters and for light vehicles were produced.

A follow-on variant was developed that became the GAU-8A 30mm cannon. Mounted on the chin, this gun became the primary armament of the A-10 Thunderbolt ground-attack aircraft. Firing rounds of tungsten and depleted uranium that destroyed armor by ki-

netic energy alone, the A-10 became famous as a tank killer in the 1991 Gulf War. Of note is the fact that the gun's cyclic rate of 4,200 rounds per minute is rumored to generate more thrust than the A-10's main engines.

Another innovative approach to improving the performance of the heavy machine gun using the Gatling multibarrel approach resulted in the development of the Externally Powered Armored Vehicle Machine Gun (EPAM). As originally conceived, the EPAM was meant to be a replacement for the coaxial machine gun on the M60 main battle tank. The prototype's action was driven and regulated by a gearbox and a series of cams. This design proved too complicated, and engineers went back to the drawing board. The result was a simpler action driven by an industrial roller chain such as those used to drive most motorcycles. The resulting gun was much less complex than the rotary cannon. Although it could not approach the rate of fire of the rotary weapons, it was much more reliable. From this effort, Hughes Tool Company of Culver City, California, introduced its 30mm chain gun in 1972, which Ian Hogg describes as "one of the few pieces of original thinking to appear in the firearms world during the second half of the century."[8] This single-barreled weapon relies on an electrically driven endless roller chain in the breech and an independently powered cartridge belt drive and is capable of firing 600 rounds per minute. The chain gun is an ideal weapon for use on helicopters and ground vehicles due to its compact design and reliability. Originally conceived in 1972 as a 30mm cannon, the design, adopted by the U.S. Army in 1976 as the M230, became the main gun armament of the AH-64 Apache attack helicopter. It was mounted in a chin pod and controlled by a computerized link to the pilot's helmet. A second model, the caliber 25mm M252 Bushmaster, was mounted in the turret of the M2 Bradley Infantry Fighting Vehicle. The weapon was so successful that Hughes decided to reconfigure the chain gun for rifle-caliber cartridges in the 1980s. This version, known as the EX-34, has been adopted as the coaxial machine gun for the M1 Abrams main battle tank. It is also manufactured under license in Great Britain, where it serves as the coaxial machine gun on the Challenger II main battle tank and on the Warrior Armored Fighting Vehicle.

The machine gun has come a long way since the early days of the Gatling gun and the earlier weapons that went before it. The Maxim and its derivatives changed the face of warfare during World War I. The successors to the early machine gun were used by every army during World War II and in every conflict since. On the battlefields

of Afghanistan and Iraq today, machine guns continue to be just as critical as they were in the earlier wars. There is little evidence to suggest that this will change in the future.

THE FUTURE OF THE MACHINE GUN

The nature of the future machine gun cannot be known with certainty, but there is no doubt that it will continue to play an important role on the ground, in the air, and at sea. Even though many machine guns remaining in service are based on designs that originated in the mid-1900s, the effort to develop a better weapons system continues.

Most armies today and in the foreseeable future will continue to use some form of 5.56mm machine gun at the squad level. However, there will still be a role for the 7.62mm machine guns, since the smaller round is not sufficiently powerful for longer ranges or for penetrating cover and light armor. Weapons expert Craig Philip believes that future designs "will probably stray from the GPMG concept, with weapons being optimized for heavier tasks."[9]

Philip and other experts suggest that technologies under consideration for potential rifle models may find their way into machine guns. One of these is caseless ammunition, under discussion for years. Theoretically, removing the brass from the case of the ammunition would greatly reduce the weight of the loaded gun. However, there are problems that accompany the weight advantage. Not the least of these is a rapid heating of the gun's chamber because there is no metal casing to help absorb the heat of the propellant explosion. Heckler & Koch have manufactured a successful automatic rifle, the G11, that uses caseless ammunition. One would think that the automatic rifle could be converted to a light machine gun, and both Heckler & Koch and GIAT, a French consortium, have developed designs for potential caseless machine guns. Yet the practical problems involved with turning the designs into actual weapons have not been overcome.

Other ideas pertain to ammunition as well. Special flechette rounds for machine guns have been discussed. Literally translated, the French term *flechette* means "little arrow"; a flechette round consists of several small, nail-like projectiles, each pointed at one end and weighted at the other by fins swaged into the rear of the projectile. Although these types of loads have been used in larger caliber artillery ammunition, flechette rounds have proved impracti-

cal in machine gun ammunition because they lack the range and punch required of a squad fire-support weapon. High-explosive rounds for machine guns are also being studied.

Some of the new ideas are being incorporated into the search for a replacement for the venerable Browning .50-caliber heavy. As squad machine guns grow smaller in caliber and vehicle-mounted cannons grow larger and heavier, there continues to be a place for the heavy, firing ammunition of perhaps caliber 12.7mm. Two attempts to improve the heavy are the Belgian FN BRG-15 and the U.S. Telescoped Ammunition Revolver Gun (TARG) produced by the Ares Corporation of Port Clinton, Ohio. The Belgian design is a gas-operated machine gun that weighs in at 132 pounds (60 kilograms). It has a unique dual-feed system, whereby two belts of ammunition can be fed into the gun simultaneously from both sides. The gunner can select which belt to fire with a selector switch. One belt can hold armor-piercing and the other standard ball ammunition, or any combination of armor-piercing, ball, and incendiary rounds. The ammunition for the BRG-15 is a specially designed 15.5mm round with a plastic driving band that engages the rifling and reduces barrel wear. This gun is suitable as a battalion/company support weapon, but its weight is a serious drawback.

The Ares TARG, first produced in 1989, was also gas-operated but used a unique four-chamber revolving cylinder, rather like a giant revolver. It used special "cased telescoped ammunition" (CTA) in 12.7mm in which the round was contained completely within the casing and surrounded by propellant. This resulted in a completely cylindrical cartridge, which allowed the case to be ejected forward as the next round was fed in from the rear. There was no belt; rounds were fed into the gun from the ammunition box by a feed rotor. The Ares TARG at 44 pounds was significantly lighter than any other heavy gun. The Ares company continued to work on the TARG for several years, but in the late 1990s the firm was taken over by Alliant Tech Systems and the TARG project was closed down.

A European consortium, CTA International, developed a 45mm cannon and a .50-caliber machine gun using CTA. The machine gun was a four-barrel, Gatling-type gun capable of a rate of fire of 4,000 rounds per minute. Design work continues and neither version of the CTA weapons has gone into production.

Other new ideas incorporate the characteristics of the heavy machine gun and the grenade launcher. One of the most interesting projects is the Objective Crew-Served Weapon (OCSW) currently under development by the United States. The OCSW is officially

defined as "a two-man portable weapon system intended to provide high probability of suppression and incapacitation against light vehicles, slow-moving aircraft and water craft out to 1000 meters and protected personnel up to a range of 2,000 meters."[10] It is intended to replace both the Browning M2HB machine gun and the Mark 19 40mm grenade launcher in the infantry squad.

The objective design for the OCSW includes a shoulder-fired, low-velocity, 25mm cannon firing a high-explosive projectile that can be either antipersonnel or a dual-purpose antipersonnel and antimaterial shell. The weapon will be fitted with a laser rangefinder and a fire-control computer and will be capable of bursting the shell above the target through the use of a sophisticated fuse on the shell.

So what direction will the designers of machine guns take in the distant future? According to weapons historian Ian Hogg, "It may be possible to develop a machine gun which is an advance upon what we already have; but will that advance be of sufficient magnitude to make it worth the enormous cost in time and money that the development of the weapon will demand?"[11] Hogg believes that unless a weapons designer can produce a weapon that fires farther and faster, produces better accuracy with more penetration, and displays other characteristics that far outperform the machine guns currently in service, "the customer will keep his wallet in his pocket."[12]

There is absolutely no denying that the machine gun has fundamentally impacted the nature of close combat since it was introduced during the U.S. Civil War. It matured during World War I and dominated ground battles during World War II. And despite the advances in weapons technology, the soldier on the ground will always need fire support, whether to suppress enemy defenses in the assault or to break up an enemy attack. Therefore, the machine gun, in some form, will always have a prominent place on the world's future battlefields.

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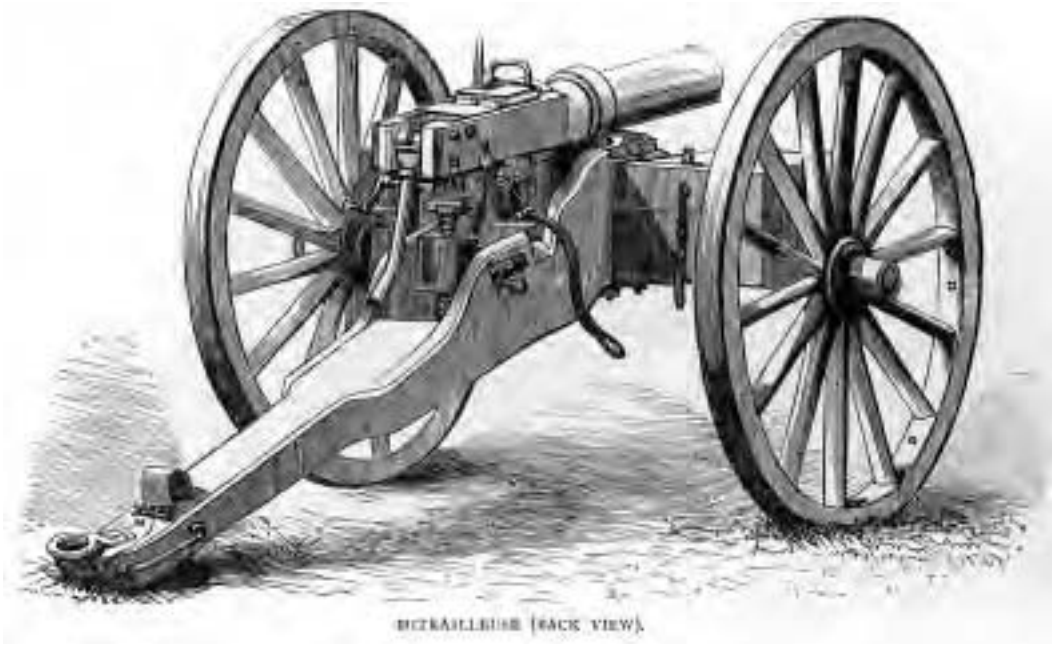
MACHINE GUN MODELS

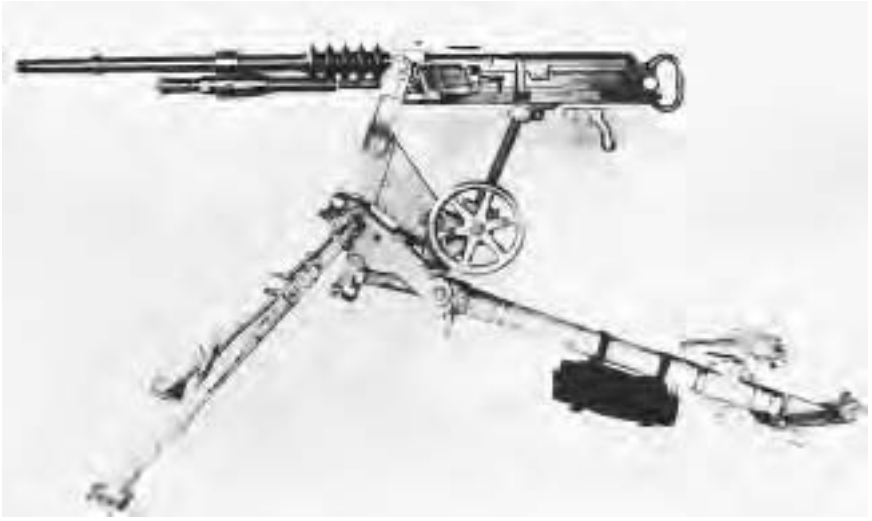
1700s AND 1800s



MONTIGNY MITRAILLEUSE (EARLY MG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 11mm
WEIGHT: 308 lbs (140 kg)
LENGTH: 54" (1370mm)
RATE OF FIRE: Volley Gun
FEED: 37-round magazine plate
MUZZLE VELOCITY: 1,345 fps (410 mps)
ORIGINAL COUNTRY OF MANUFACTURE: France
FIRST PRODUCED: 1867
SUMMARY: The Mitrailleuse was developed by Belgian engineer Joseph Montigny, who sold guns to the French in 1869. It was a breech-loading mechanical machine gun consisting of barrels fitted together, arranged so that the barrels could be fired simultaneously, or successively, and rapidly. The French hoped it would help them prevail in the Franco-Prussian War of 1870, but it did not have the desired impact primarily because the French used them as artillery rather than as infantry support weapons.



HOTCHKISS MODÈLE 1897 MACHINE GUN (MMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 0.315" (8mm)
WEIGHT: 52 lbs (23.6 kg)
LENGTH: 50" (1,270mm)
RATE OF FIRE: 400–600 rpm
FEED: 24- or 30-round metal strips
MUZZLE VELOCITY: 2,400 fps (725 mps)
ORIGINAL COUNTRY OF MANUFACTURE: France
FIRST PRODUCED: 1897
SUMMARY: The first Hotchkiss machine gun to see service was the Modèle 1897, closely followed by the export model, the Modèle 1898. These were followed by the Modèle 1900 and the Modèle 1914. They were all very similar gas-operated guns with heavy, air-cooled barrels. They all had two significant features: five large cooling rings around the end of the barrel, and a metal strip feed. The metal strip feed system limited the length of bursts, so the Modèle 1914 featured a form of belt feed in which three-round ministrips were joined up in 249-round lengths. The Hotchkiss guns were robust and serviceable weapons that were manufactured in various calibers. They were, however, heavy and cumbersome, and by 1939 most had been relegated to static defensive roles. Nevertheless, they were used by France, Belgium, China, Japan, Yugoslavia, Norway, Poland, and Rumania.

PUCKLE GUN (EARLY MG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 1.2”
WEIGHT: 120 lbs (50 kg) including tripod
LENGTH: 46” (1168mm)
RATE OF FIRE: 9 rpm
FEED: mechanical revolver cylinders
MUZZLE VELOCITY: 395 fps (120 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Great Britain
FIRST PRODUCED: 1717
SUMMARY: The Puckle gun was a British flintlock machine gun invented by James Puckle. It took a nine-round revolving block, was mounted on a tripod, and was designed to be portable and especially to prevent an enemy boarding a ship. Puckle demonstrated two versions of the basic design, called the Defence Gun. One weapon, intended for use against Christian enemies, fired conventional round bullets, while the second variant, designed to be used against the Muslim Turks, fired square bullets, which were believed to cause more severe and painful wounds than spherical projectiles. The Puckle failed to attract investors and never achieved mass production or sales to the British armed forces.

MAXIM HEAVY MACHINE GUN (EARLY MG)

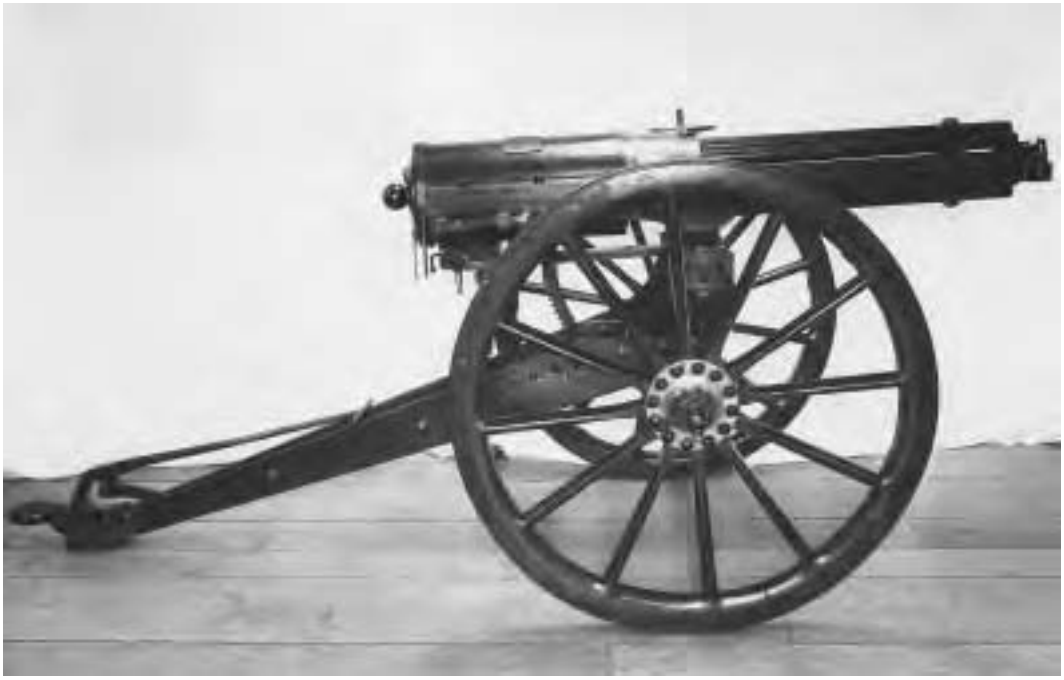
Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .303
WEIGHT: 60 lbs (27.2 kg)
LENGTH: 42.51" (107.9 cm)
RATE OF FIRE: 550 rpm
FEED: 250-round fabric belt
MUZZLE VELOCITY: 2,440 fps (744 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Great Britain
FIRST PRODUCED: 1884–1885
SUMMARY: Hiram Maxim, an American, developed the first automatic machine gun. The first model, built in Maxim's London workshop, was chambered for the British caliber .45 Martini-Henry service cartridge. Vastly different from any machine gun that had been seen before, the Maxim was recoil-operated and continued to fire as long as the trigger was depressed and it had ammunition. Not entirely satisfied with his first design, Maxim introduced a new design in 1885, which was so efficient that it was adopted by many armies all over the world and served unchanged in many of these armies until World War II. The first use of the 1885 model in combat was in 1888. The Maxim design generated two variant models, one manufactured in partnership in 1912 with Albert Vickers after Maxim's original patents had expired. It became known as the Vickers. The other variant was the German Parabellum MG, also developed in 1912. These machine guns were responsible for untold numbers of dead soldiers on the battlefields of World War I.

NORDENFELT 5-BARREL MACHINE GUN (EARLY MG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

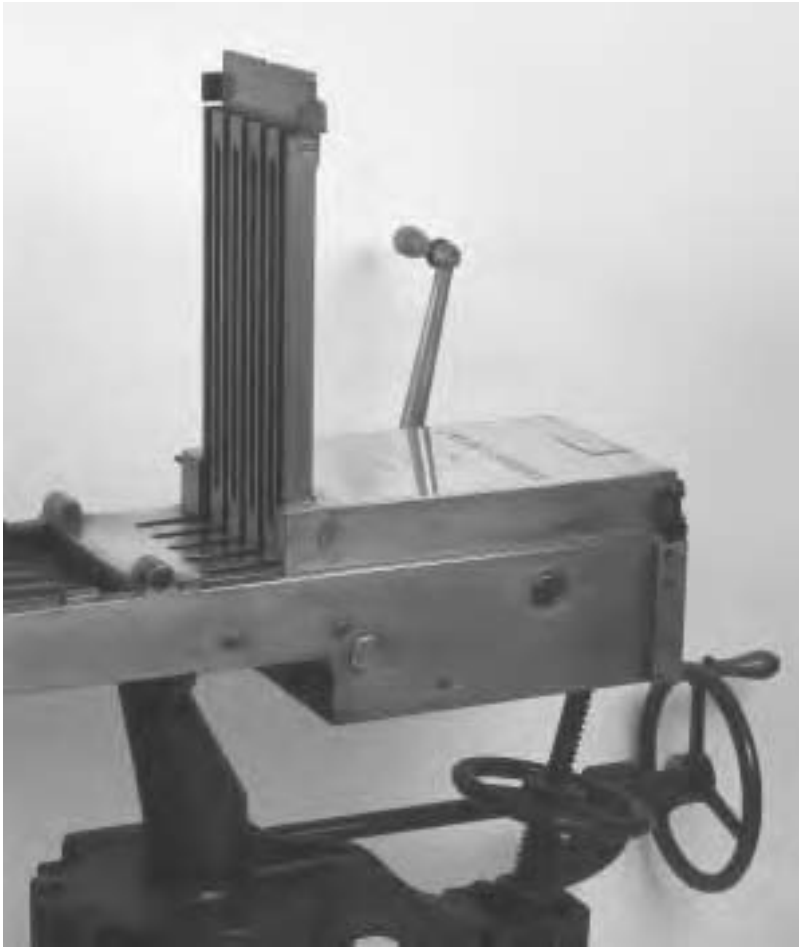
CALIBER: .45
WEIGHT: 372 lbs (168.74 kg) with shields, hoppers, cone, and empty distributor
LENGTH: 46" (1168mm)
RATE OF FIRE: 600 rpm
FEED: 50-round hopper; 50-round distribution box
MUZZLE VELOCITY: unknown
ORIGINAL COUNTRY OF MANUFACTURE: Great Britain
FIRST PRODUCED: 1884
SUMMARY: The Nordenfelt machine gun is a battery gun invented by a Swede, Helge Palmcrantz, and was named for the Swedish banker who set up a factory in England to build Palmcrantz's design. The Nordenfelt could be described as a mechanized battery gun that was essentially a hybrid of the Mitrailleuse and the Gatling. There were versions of this design that had from two to 12 barrels mounted laterally on a pedestal or a carriage. The Nordenfelt gun saw service in navies in Europe, as well as in the United States.



GATLING GUN (EARLY MGS)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .45
WEIGHT: 444 lbs (210 kg)
LENGTH: 59.41" (150.9 cm)
RATE OF FIRE: 1000 rpm
FEED: 240-round drum magazine
MUZZLE VELOCITY: 1,300 fps (396 mps)
ORIGINAL COUNTRY OF MANUFACTURE: United States
FIRST PRODUCED: 1864
SUMMARY: The Gatling gun was the first successful mechanical machine gun. First used in combat during the U.S. Civil War, it went on to see service throughout the world. Richard J. Gatling began work on his invention in 1861 but did not perfect it until 1864, when it was adopted by the U.S. Army. The British Army adopted a 10-barrel version in 1874 and the Royal Navy a .65-inch version in 1875. The major feature of the Gatling gun was the revolving barrel system that allowed each barrel to cool between shots. The Gatling was a very efficient mechanism and proved to be very reliable. In the 1890s, the inventor Gatling went so far as to mount an electric motor on one of his guns, achieving an almost unbelievable rate of fire of 3,000 rpm. Gatling's concept would be resurrected during the Cold War to provide the basis for the modern minigun.



GARDNER GUN (EARLY MGS)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .45
WEIGHT: 290 lbs (131.5 kg)
LENGTH: 53.5" (135.9 cm)—gun only
RATE OF FIRE: 650 rpm
FEED: vertical 50-round magazine
MUZZLE VELOCITY: 1,350 fps (412 mps)
ORIGINAL COUNTRY OF MANUFACTURE: United States
FIRST PRODUCED: 1876
SUMMARY: The Gardner machine gun was developed by an American, William Gardner, who had served in the U.S. Civil War and had seen a variety of battery guns and the Gatling in action. The Gardner consisted of two barrels mounted side-by-side and closed by two sliding breech blocks. Gardner was unable to interest U.S. military authorities in his gun because they had already invested in the Gatling Gun. The inventor took his weapon to Europe, where he was able to sell it in two- and five-barrel versions (shown in photo) to the British Army and Royal Navy. It remained in the British inventory until 1926.

COLT MODEL 1895 LIGHT MACHINE GUN (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .303
WEIGHT: 40 lbs (18.14 kg)
LENGTH: 41.7" (1059.18mm)
RATE OF FIRE: 400 rpm
FEED: 250-round fabric belt
MUZZLE VELOCITY: 2,500 fps (762 mps)
ORIGINAL COUNTRY OF MANUFACTURE: United States
FIRST PRODUCED: 1895
SUMMARY: The Colt Model 1895 was often known as the Potato Digger because of the unusual reciprocating arm under the front of the gun. One of John Browning's designs made by the Colt factory in the United States had a heavy, solid barrel mounted on top of a box casing. The gun was sold to U.S. forces and exported to Great Britain, Spain, Italy, and Russia.

MACHINE GUN MODELS

EARLY 1900s

SCHWARZLOSE MACHINE GUN (HMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .315 (8mm)
WEIGHT: 83.75 lbs (39.7 kg) combined weight of gun and tripod
LENGTH: 42" (1066mm)
RATE OF FIRE: 400 rpm
FEED: 250-round fabric belt
MUZZLE VELOCITY: 2,050 fps (620 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Austria
FIRST PRODUCED: 1905
SUMMARY: The Schwarzlose machine gun was first produced in 1905 by Steyr in Austria. It is unique in that it employs the retarded-blowback system. It is extremely heavy and thus its parts never seemed to wear out. For that reason, many of the weapons were still in service in 1939. It has a short barrel and a prominent flash hider. Early models had to use oiled cartridges, but this feature was later designed out. There were many variations of the basic weapon design, and it was manufactured and used by Austria, Yugoslavia, Bulgaria, Holland, Rumania, Hungary, Italy, and Greece.

LEWIS GUN (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .303 (7.7mm)
WEIGHT: 27 lbs (12.15 kg)
LENGTH: 49.2" (1250mm)
RATE OF FIRE: 450 rpm
FEED: 47- or 97-round overhead drum magazine
MUZZLE VELOCITY: 2,440 fps (744 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Belgium
FIRST PRODUCED: 1911
SUMMARY: The Lewis gun was invented by an American, Samuel McClean, at the turn of the century, but it was developed and sold by Colonel Isaac Lewis, another American. It was not at first taken up by the United States but rather was first produced by Belgium and then Great Britain. At 12 kilograms it was far lighter than the Vickers machine gun, and in 1915 the British Army decided to purchase the gun for use on the Western Front. Another advantage of the Lewis gun was that six of these guns could be made in the time needed to produce one Vickers. Although too heavy for efficient portable use, it became the standard support weapon for the British infantry during World War I. When the United States entered the war, production started there as well, and large numbers were produced to equip the U.S. forces in France. It was also used as an aircraft gun, both fixed and flexible. It was manufactured in the United States, Great Britain, Japan, Belgium, and France between the wars and was exported to many countries. In 1939, it was in use by many of the combatant nations, and it saw extensive use on many fronts during World War II. The Lewis gun was a gas-operated weapon with a mechanism that has stood the test of time, for it is still in use in some modern designs.

ZB VZ\26 (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .312 (7.92mm)
WEIGHT: 21.3 lbs (9.6 kg)
LENGTH: 45.75" (1161mm)
RATE OF FIRE: 500–550 rpm
FEED: 20- or 30-round box magazine
MUZZLE VELOCITY: 2,500 fps (762 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Czechoslovakia
FIRST PRODUCED: 1926
SUMMARY: The ZB 26 was developed by Vaclav Holek for the Czech firm Eskoslovenská Zbrojovka at Brno in 1926. It was a well-designed, gas-operated gun that soon proved popular and was exported all over the world. Many were manufactured for the Czech Army; these were taken by the Germans in 1938. Many overseas states took up licenses for the manufacture of this gun, and the ZB 26 design eventually led to the development of the Bren in Great Britain.

MADSEN LIGHT MACHINE GUN (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .303" (7.7mm)
WEIGHT: 20 lbs (9.07 kg)
LENGTH: 45" (1143mm)
RATE OF FIRE: 450 rpm
FEED: 20-. 25-, 30-, or 40- round box magazine
MUZZLE VELOCITY: 2,350 fps (715 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Denmark
FIRST PRODUCED: 1904
SUMMARY: The Madsen was one of the earliest light machine guns. It was produced in various models and calibers and was sold all over the globe, including Great Britain, Bulgaria, China, Estonia, Finland, France, Germany, Holland, Hungary, Italy, Yugoslavia, Lithuania, and Norway. It had a very complex mechanism and was expensive to manufacture, but its major advantage was reliability. It served in a variety of roles and was fitted into tanks, armored fighting vehicles, and aircraft, seeing service in the military forces of many nations during World War II.

MITRAILLEUSE ST. ETIENNE MODÈLE 1907 (HMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .0315 (8mm)
WEIGHT: 56.75 lbs (25.4 kg)
LENGTH: 46.5" (1180mm)
RATE OF FIRE: 400-600 rpm
FEED: 24- or 30-round metal strips
MUZZLE VELOCITY: 2,300 fps (700 mps)
ORIGINAL COUNTRY OF MANUFACTURE: France
FIRST PRODUCED: 1907
SUMMARY: The Mitrailleuse Saint Étienne Modèle 1907 was an attempt to improve on the basic Hotchkiss design. First built in the state arsenal, the Saint Étienne gun was not a success and was never adopted by the French for general use by its forces. It was poorly designed and not very reliable. Nevertheless, it was sold to Greece, Yugoslavia, and Rumania. In 1940 and with the fall of France, most of the Saint Étienne guns came under German control. The Germans gave the weapon a new designation, sMG 256, but they did not use it much due to its notorious unreliability.

FUSIL MITRAILLEUR HOTCHKISS MODÈLE 1909 (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 6.5mm, 7.7mm, 7.9mm, .303
WEIGHT: 25.79 lbs (11.7 kg)
LENGTH: 46.85" (1190mm)
RATE OF FIRE: 500 rpm
FEED: 30-round metal strip
MUZZLE VELOCITY: 2,428 fps (740 mps)
ORIGINAL COUNTRY OF MANUFACTURE: France
FIRST PRODUCED: 1909
SUMMARY: The Fusil Mitrailleur Hotchkiss Modèle 1909 was the first true light machine gun. It is also often referred to as the Benet-Mercier. It employed the same gas-operated mechanism as the larger Hotchkiss guns. Feed was by the usual metal strip used in all Hotchkiss guns, but on the 1909 model it was inverted, a feature that often led to feed troubles. The Modèle 1909 was used widely in World War I by the French, and it was also adopted by Great Britain and the United States. By the beginning of World War II, the Modèle 1909 had been phased out of service in France and the United States, but stocks were kept in Great Britain, where they were used as airfield defense weapons and for air-defense weapons on British merchant ships. The gun was remodeled in 1922 and again in 1926. The later models were exported to Greece and South Africa.

FUSIL-MITRAILLEUR MODÈLE 1915—CHAUCHAT (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 0.315" (8mm)
WEIGHT: 20 lbs (9.2 kg)
LENGTH: 45" (1143mm)
RATE OF FIRE: 250–300 rpm
FEED: 20-round curved magazine
MUZZLE VELOCITY: 2,300 fps (700 mps)
ORIGINAL COUNTRY OF MANUFACTURE: France
FIRST PRODUCED: 1915
SUMMARY: The Chauchat machine gun (CSRG, from the initials of the original name of the weapon, Gladiator, and the initials of Chauchat, Suterre, and Riberyrolle, the three men who made up the committee who approved the design) was first produced in 1915. Used by French troops during World War I, it soon won the reputation as the most hated gun ever issued to any army at any time in history. It was extremely unreliable, poorly made, and difficult to use efficiently. The gun, which failed in every role in which it was tried, gave rise to a series of fraud and graft charges, mainly due to the shoddy materials used in manufacture. Some design modifications were made to redress identified ills, but the gun never got over its well-deserved reputation. By 1939, the French had relegated all remaining Chauchats to reserve stocks. The weapon was also used by Belgium, Greece, Yugoslavia, and Rumania.

MG08 (HMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 0.312 (7.92mm)
WEIGHT: 137 lbs (62 kg)
LENGTH: 46.25" (1175mm)
RATE OF FIRE: 300–450 rpm
FEED: 250-round fabric belt
MUZZLE VELOCITY: 2,925 fps (900 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Germany
FIRST PRODUCED: 1908
SUMMARY: The Maschinengewehr 08 (MG08) was built by the Deutsche Waffen and Munitionsfabriken at Spandau in Berlin and is thus often referred to as the Spandau. The MG08 was a water-cooled machine gun with a heavy water jacket around the barrel. It was the German licensed copy of the famous Maxim. During World War I, it took a fearsome toll on battlefields like the Somme. In 1919, it was responsible for the inclusion of a clause in the Versailles Treaty prohibiting the development of water-cooled machine guns. The MG08 was a heavy gun and was very reliable. It was mounted on either a sledge mounting (later on a tripod). There was a lightened version, known as the LMG08\15, used as the primary armament on many German aircraft during World War I. Many were still in service when World War II began.

PARABELLUM MODEL 08 MACHINE GUN (HMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .312 (7.92mm)
WEIGHT: 40.51 lbs (18.37 kg)
LENGTH: 46.25" (117.5 cm)
RATE OF FIRE: 450 rpm
FEED: 250-round fabric belt
MUZZLE VELOCITY: 2,925 fps (892 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Germany
FIRST PRODUCED: 1915
SUMMARY: An improvement of the German Parabellum MG, which was a derivative of the Maxim, the Model 08 became the standard German machine gun in 1915 and wrought devastation on the battlefields of the Western Front during World War I. It was modified by removing the tripod, affixing a wooden butt and pistol grip, and adding a bipod to create a lighter machine gun, the MG 08\15. It could thus be carried by one man in the advancing infantry, leading eventually to the whole light machine gun concept.

MP18 (SMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 9mm
WEIGHT: 9.22 lbs (4.18 kg)
LENGTH: 32.01" (815mm)
RATE OF FIRE: 450 rpm
FEED: 32-round snail drum or 32-round box magazine
MUZZLE VELOCITY: 1,168 fps (365 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Germany
FIRST PRODUCED: 1916
SUMMARY: The Bergmann MP18 was the first true submachine gun, and like any new weapon not all armies realized its great potential. It was designed by Hugo Schmeisser and was first produced in limited numbers in 1916. It fit very well with the newly developed German storm-trooper tactics and soon found its place in battle as a means of providing maximum firepower in a light, portable, automatic-fire weapon. The MP18 was produced from 1916 to 1945. It took a 9mm round from a 32-round snail drum or 32-round box magazine. It had a cyclic rate of 400 rpm and a muzzle velocity of 365 mps. The MP18 was simple, strong, and reliable, and it more or less set the pattern for the various submachine guns developed in Europe.

MP28 (SMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 9mm Parabellum
WEIGHT: 8 lbs, 13 oz (4 kg)
LENGTH: 32" (813mm)
RATE OF FIRE: 500 rpm
FEED: 32-round box magazine
MUZZLE VELOCITY: 1,250 fps (380 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Germany
FIRST PRODUCED: 1928
SUMMARY: The MP28 was no more than the MP18 with some minor improvements. The main modification was the addition of a selector switch that permitted semi-auto as well as automatic fire. Produced by the Bergmann factory, the MP28 was virtually indestructible. It was also sold to several South American countries, made under license in Belgium, and copied by Spanish and Chinese factories. It was used by the German Army in World War II.

VICKERS .303, MARK 1 (HMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .303 (7.7mm)
WEIGHT: 88.5 lbs (40 kg) complete with water and tripod
LENGTH: 45.5" (1155mm)
RATE OF FIRE: 450–500 rpm
FEED: 250-round fabric belt
MUZZLE VELOCITY: 2,445 fps (744 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Great Britain
FIRST PRODUCED: 1912
SUMMARY: The Vickers Mark 1 was a revision of the original Maxim design that produced a mechanism that was to remain unchanged for the life of the weapon. It was one of the most rugged and dependable heavy machine guns during World War II. The British Army and its allies used the gun in all theaters of war, and it was also used by many nations such as Lithuania, Russia, Latvia, Holland, and the United States. During its life, there were variations and changes, but the overall mechanism remained unchanged and was still in use in some countries into the 1970s.

VILLAR PEROSA (EARLY MG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 9mm Glisenti
WEIGHT: 14 lbs, 6 oz (6.52 kg)
LENGTH: 21" (533mm)
RATE OF FIRE: 1200 rpm
FEED: 25-round box magazine
MUZZLE VELOCITY: 1,200 fps (365 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Italy
FIRST PRODUCED: 1915
SUMMARY: This weapon is often characterized as the first submachine gun ever made. Tactically, however, it was designed and originally deployed as a light machine gun for use by Italian alpine troops. It was a unique design that utilized a nickel and steel twin-barrel mechanism, each of which fired a 25-round box magazine of 9mm Glisenti pistol ammunition—essentially a low-powered 9mm Parabellum cartridge. The twin-barreled weapon was attached to a platform that was suspended by a strap around the machine-gunner's neck and shoulders. The Villar Perosa also appeared in conjunction with a number of mountings, including tripods, fixed shields, on bicycles, on boats, and occasionally in armored cars.

TYPE 11 (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 6.5mm
WEIGHT: 22.5 lbs (10.2 kg)
LENGTH: 43.5" (110 cm)
RATE OF FIRE: 500 rpm
FEED: hopper
MUZZLE VELOCITY: 2,500 fps (730 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Japan
FIRST PRODUCED: 1922
SUMMARY: The Type 11 was the first light machine gun that Japan produced. The Type 11 used the five-round rifle clip as the basis for its feed system. Six clips were placed on a side mounted hopper and fed into the chamber minus the metal strip. This approach was supposed to make the weapon easier to maintain, but it caused no end of problems. Chief among them was the need to oil each round against the effects of dust and dirt from the exposed mechanism. In fact, the debris simply mixed with the oil to cause frequent stoppages. This flaw was eliminated only by using an even less powerful 6.5mm round, which negated the envisioned cooperation with the rifleman who used the same standard ammunition it was originally designed for.

PULEMET MAKSIMA OBRAZETS 1910 (HMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .30 (7.62mm)
WEIGHT: 152.5 lbs (74.0 kg)
LENGTH: 43.6" (1107mm)
RATE OF FIRE: 520–600 rpm
FEED: 250-round fabric belt
MUZZLE VELOCITY: 2,822 fps (863 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Russia
FIRST PRODUCED: 1905
SUMMARY: The Pulemet Maksima (PM) 1910 was one of the longest-lived of the Maxim variants. First produced as the PM1905, it was water-cooled and had a bronze water jacket. It became the PM1910 with the substitution of a steel water jacket and was produced in vast numbers until 1943. The weapon, extremely reliable, was sturdily built and could take rough handling. The gun was placed on a variety of mounts, most commonly the Sokolov carriage. The Sokolov was essentially a small artillery carriage with steel wheels, a traversing turntable, and a U-shaped hand-towing trail. One variant was a horse-drawn cart mounting two PM1910s, called the Tachanka. Another variant was mounted on a special antiaircraft tripod, and there were trucks equipped to carry special quadruple-mounted PM1910s, also for antiaircraft use. The PM1910 was used extensively by Soviet forces during World War II.

PULEMET DEGTYAREV (DP) (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .30 (7.62mm)
WEIGHT: 26.23 lbs (11.9 kg)
LENGTH: 49.8" (1265mm)
RATE OF FIRE: 520–580 rpm
FEED: 47-round drum
MUZZLE VELOCITY: 2,770 fps (844 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Soviet Union
FIRST PRODUCED: 1926
SUMMARY: The DP (Pulemet Degtyareva Pekhotnii) light machine gun was the first truly Russian machine gun to see service. It was designed during the early 1920s by Vasily Alexeyevich Degtyarev; the first model was known as the DP1926. Two years later, this gun, with a new modification, was put into Russian service as the DP1928, or DP. Ever since 1928, the DP has been one of the finest guns in its class because of its simplicity, light weight, and reliability. The gas-operated system was simple, having only six moving parts, and was reliable in a range of conditions. The DP was used in very large numbers throughout World War II and remains in service in armies today. The main weakness of the DP is the operating spring under the barrel, which becomes very hot during prolonged firing and causes the spring to weaken and lead to malfunctions. This shortcoming was modified out with the 1944 model. There was an antiaircraft variant known as the DA, as well as a tank version called the DT.

PULEMET DEGTYAREVA TANKOVII (DT) (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .30 (7.62mm)
WEIGHT: 27.91 lbs (12.69 kg)
LENGTH: 46.5" (1181mm)
RATE OF FIRE: 600 rpm
FEED: 60-round drum
MUZZLE VELOCITY: 2,756 fps (839 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Soviet Union
FIRST PRODUCED: 1929

SUMMARY: The DT (Pulemet Degtyareva Tankovii) is a close relative of the DP. It was originally designed for use in armored vehicles but is basically the same as the DP. It has an adjustable metal butt and can be fitted with a bipod for ground use. The DT was fitted to most of the Russian tanks used during World War II, including the famous T34 series.

BROWNING AUTOMATIC RIFLE (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .30 (7.62mm)
WEIGHT: 19.4 lbs (8.73 kg)
LENGTH: 47.8" (1214mm)
RATE OF FIRE: 500–600 rpm or 300–350 rpm
FEED: 20-round box magazine
MUZZLE VELOCITY: 2,650 fps (808 mps)
ORIGINAL COUNTRY OF MANUFACTURE: United States
FIRST PRODUCED: 1917
SUMMARY: The Browning Automatic Rifle (BAR) was something of a hybrid. To U.S. forces it was an automatic rifle, but to the rest of the world it was a very light machine gun. It was developed to boost infantry firepower in World War I and was first used in 1918. It was produced in the thousands in a wide variety of models and calibers, with three main models: the original, which was a hand-held gun; the Model 1918A1, which was fitted with a shoulder strap, a bipod, and a flash-hider; and the Model 1919A2, which was the World war II variant. The Model 1919A2 was fitted with a bipod and a butt monopod. This model had two rates of automatic fire, instead of selective fire, but this feature was sometimes removed. The BAR was used by the United States, Great Britain, Belgium, China, and Russia during World War II. It was a very reliable weapon and can still be found in armies around the world.

BROWNING M1917 MACHINE GUN (HMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .30 (7.62mm)
WEIGHT: 85.75 lbs (38.75 kg)—complete without water
LENGTH: 38.64" (981mm)
RATE OF FIRE: 450–600 rpm
FEED: 250-round fabric or metal link belt
MUZZLE VELOCITY: 2,800 fps (854 mps)
ORIGINAL COUNTRY OF MANUFACTURE: United States
FIRST PRODUCED: 1917
SUMMARY: The M1917 was a water-cooled machine gun that resembled in appearance the British Vickers, but it had a pistol grip instead of the British double spade grip. It employed a recoil-operated action, which, once perfected, remained virtually unchanged in all future Browning designs. The M1917 was manufactured in the thousands by companies and gradually modified until a drastic revision produced the M1917A1 in 1936. The M1917A1 was outwardly the same as the original version, but there were changes to the feed system, sights, and tripod mounting. The revised version became the standard support machine gun of the U.S. Army during World War II and served for many years thereafter. During the war, more than 53,000 M1917A1s were manufactured.

BROWNING M1919 (GPMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .30 (7.62mm)
WEIGHT: 31 lbs (14.05 kg)
LENGTH: 41" (1041mm)
RATE OF FIRE: 400–500 rpm
FEED: 250-round fabric or metal link belt
MUZZLE VELOCITY: 2,800 fps (853 mps)
ORIGINAL COUNTRY OF MANUFACTURE: United States
FIRST PRODUCED: 1919
SUMMARY: The Browning M1919 Machine Gun differed from the M1917 Browning only in the use of an air-cooled barrel. Other than that, it employed the same basic mechanism as the earlier Browning model. The M1919 was originally designed as a tank gun, but the model tank for which it was developed was never built. The machine gun was produced in variations; more than 438,000 were produced during World War II and were used by most Allies. The weapon was very reliable, even though it was a little heavy for a light machine gun. In addition to widespread use as an infantry weapon, it was adapted for use on tanks and other armored vehicles; it was also used as the basis for a range of aircraft machine guns. It is still being used in many armies today.

BROWNING M2 MACHINE GUN (HMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .50 (12.7mm)
WEIGHT: 64 lb (38.22 kg)
LENGTH: 65" (1653mm)
RATE OF FIRE: 500 rpm
FEED: 110-round metal link belt
MUZZLE VELOCITY: 2,947 fps (898 mps)
ORIGINAL COUNTRY OF MANUFACTURE: United States
FIRST PRODUCED: 1921
SUMMARY: The first Browning .50-Cal was produced in 1921 as the M1921, but it developed into the M2, which formed the basis for a series of heavy machine guns all using the same mechanism and differing only in the method of installation and the type of barrel used. One variant with a water-cooled barrel was used as an antiaircraft weapon on U.S. Navy vessels. Another air-cooled variant was used extensively on combat aircraft during World War II, and more than 1,485,000 of the aircraft version were produced for use in fighters and bombers. M2s were also installed on tanks and other armored vehicles, as well as on many naval vessels for antiaircraft and close-in protection. It was, and remains, a very reliable machine gun with devastating firepower. It is still being used by the U.S. Army and the U.S. Marine Corps, as well as in many other armies.

THOMPSON MODEL M1A1 (SMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .45
WEIGHT: 10.75 lbs (4.88 kg)
LENGTH: 33.75" (85.7 cm)
RATE OF FIRE: 700 rpm
FEED: 20- or 30-round box magazine, or 50- or 100-round drum magazine
MUZZLE VELOCITY: 9,200 fps (282 mps)
ORIGINAL COUNTRY OF MANUFACTURE: United States
FIRST PRODUCED: 1921
SUMMARY: The Thompson was named for Brigadier General Taliaferro Thompson, but the actual design was due to Theodore Eickhoff and Oscar Payne, and the breech-locking system was devised by Commander John B. Blish, U.S. Navy. It was developed to address the need for a new type of weapon to break the deadlock of trench warfare during World War I. The war ended before the weapon was completed in 1921. The original model, called the Persuader, was belt-fed, but the rate of fire was too great for the feed system, and so it was redesigned as the Annihilator, using a box magazine. The final version, which appeared in 1919, became known as the Tommy Gun and featured the 50-round drum magazine that came to be associated with the Thompson. Thompson's Auto-Ordnance Corporation had no manufacturing facilities, so he had the components for 15,000 guns made by Colt. The first batch of completed weapons was delivered in March 1921. The gun was made infamous as the "Chicago Piano" by Al Capone during the 1920s. The U.S. Marines took Thompsons to Nicaragua and Shanghai for military use. The start of World War II created a great demand. A new model, the M1, entered service in 1942. A further modification was made to the firing pin, resulting in the M1A1, which proved popular with U.S. and British troops because of its reliability and stopping power. Eventually 1.75 million were made, and they were used in all theaters of war.

MACHINE GUN MODELS

1930s

OWEN (SMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 9x19mm Parabellum
WEIGHT: 9 lbs, 5 oz (4.21 kg)
LENGTH: 32" (813mm)
RATE OF FIRE: 700 rpm
FEED: 33-round box magazine
MUZZLE VELOCITY: 1,378 fps (420 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Australia
FIRST PRODUCED: 1939
SUMMARY: This weapon was a simple blowback submachine gun developed by Evelyn Owen in caliber .22 in June 1939, but the Australian Army was not interested. On the outbreak of World War II, Owen entered the army and left his gun and designs with a friend, who managed to persuade the Army Inventions Board in January 1941 to try the design. The board asked Lysaghts works to manufacture a prototype in caliber .32. The Australian Army, waiting on delivery of the Sten submachine gun, decided to purchase 100 guns in the larger .38 caliber. However, the caliber .38 revolver round proved to be ineffective as a submachine gun cartridge, and Lysaghts changed the design to chamber the 9mm Parabellum round. It was tested against the Sten and the Thompson submachine guns and did very well. It went into production, but due to a shortage of machine tools full production (2,000 per month) was not achieved until mid-1942. There were several versions of the Owen. The first, the Mark I, went through several modifications. Total wartime production was about 45,000 before Lysaghts ended manufacture in September 1945. The Owen remained in use until the 1960s; some are still held in reserve stores.

STEYR-SOLOTHURN MP34 (SMG)

CALIBER: 9x19mm Parabellum
WEIGHT: 8 lbs, 8 oz (3.87 kg)
LENGTH: 33.5" (850mm)
RATE OF FIRE: 500 rpm
FEED: 32-round magazine
MUZZLE VELOCITY: 1,250 fps (381 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Austria
FIRST PRODUCED: 1934
SUMMARY: This weapon defined the lengths that German arms makers went to subvert the Versailles Treaty during the years between the world wars. Rheinmetall, a German arms maker, designed this submachine gun, then passed along the designs to a Swiss subsidiary, Waffenfabrik Solothurn AG, which made the prototypes, carried out the testing, and made whatever modifications were required. The prototype and designs then went to Waffenfabrik Steyr in Austria, where the guns were manufactured. The MP34 was adopted by the Austrian and Hungarian Armies and was sold widely in South America and the Far East. The MP34 was extremely well-made, machined from solid steel, and the quality and finish were perhaps the highest ever seen in this class of weapon. Although the official submachine gun of the German Army was the MP40, the Solothurn was also issued in large numbers and remained in service until 1945.
CALIBER: 7.92mm

MPE (SMG)

CALIBER: 9x19mm Parabellum
WEIGHT: 9 lbs, 3 oz (4.15 kg)
LENGTH: 9.84" (890mm)
RATE OF FIRE: 500 rpm
FEED: 20- or 30-round box magazine
MUZZLE VELOCITY: 1,250 fps (381 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Germany
FIRST PRODUCED: 1931
SUMMARY: Developed by a gunsmith named Heinrich Vollmer, who made a small number of submachine guns for sale to police forces, the designs were sold to Erfurter Machinenwerke (Erma). After selling his patents, Vollmer went to work for Erma as chief designer. With a few minor changes, the Vollmer became the Maschinenpistole Erma (MPE). It was manufactured by Erma until 1938, when mass production of the MP38 swept all else aside at the Erma factory. Nevertheless, the MPE remained in use in the German Army until about 1942. It was also sold in some quantities in South America.

BESA (HMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

WEIGHT: 47 lbs (21.5 kg)
LENGTH: 43.5" (1105mm)
RATE OF FIRE: 750–850 rpm
FEED: Belt-fed
MUZZLE VELOCITY: 2,700 fps (825 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Czechoslovakia\Great Britain
FIRST PRODUCED: 1935
SUMMARY: In early 1930 Václav Holek and Miloslav Rolcik started development of a heavy machine gun that after several modifications resulted in the ZB 1935 HMG that showed itself vastly superior to the World War I–era Schwarzlose machine guns then still in use. The weapon was also bought by Great Britain, which manufactured it under license by BSA Ltd. and under the designation Besa machine gun for use as a vehicle-mounted gun for tanks. An interesting fact is that because the Besa was identical to the Czech origin, both were in the 7.92mm Mauser caliber. Because the British armor wanted the Besa, but the Besa could not be converted to fire the British .303 ammunition, and because the infantry did not want to switch over all their Enfields to the German caliber, the tankers were granted an exception and even had their own special manufacturing plant in England for producing the German ammunition type. The weapon was integrated into German Army use under the designation MG37(t); production was continued until 1942, when it was switched over to produce parts for German weapon designs.

HOTCHKISS MITRAILLEUSE MODÈLE 1930

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .519" (13.2mm)
WEIGHT: 87 lbs (37.5 kg)
LENGTH: 95" (2413mm)
RATE OF FIRE: 450 rpm
FEED: 30-round box magazine or 15- or 20 round strips
MUZZLE VELOCITY: 2,210 fps (674 mps)
ORIGINAL COUNTRY OF MANUFACTURE: France
FIRST PRODUCED: 1930
SUMMARY: The Hotchkiss company introduced an enlarged and modernized version of the 11mm Modèle de Ballon of 1917; it was designated the Mitrailleuse Hotchkiss d 13mm Modèle 1930. It resembled an enlarged Bren gun and employed the Hotchkiss gas-operated mechanism together with a curved 30-round overhead box magazine. It was intended for roles in which a different mounting could be utilized. It was used for antitank and infantry use, cavalry support, and in the anti-aircraft mode. It was exported to Poland, Russia, Rumania, Yugoslavia, and Greece, but it was sold in only small quantities because it was expensive and difficult to maintain. With the fall of France in 1940, many of the captured French guns were used by the Germans as the 13.2mm MG 271(f), and many were used in coastal defenses. The Japanese also produced a copy that was known as the Type 93.

MG13 (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 0.312 (7.92mm)
WEIGHT: 24 lbs (10.89 kg)
LENGTH: 57.75" (1466mm)
RATE OF FIRE: 650 rpm
FEED: 25-round box magazine
MUZZLE VELOCITY: 2,700 fps (823 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Germany
FIRST PRODUCED: 1932

SUMMARY: The Maschinengewehr Modell 13 (MG13) was an air-cooled rebuild of the old World War I Dreyse MG15 water-cooled machine gun. It entered service with the German Army in 1932, but by 1938 most were sold off to Portugal. Some were retained and used in small numbers by various second-line German units.

MG15 BERGMANN (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 7.92mm Mauser
WEIGHT: 28 lbs (12.7 kg) with stock and bipod
LENGTH: 52.5" (1335mm)
RATE OF FIRE: 850 rpm
FEED: 75-round saddle drum magazine
MUZZLE VELOCITY: 2,480 fps (755mps)
ORIGINAL COUNTRY OF MANUFACTURE: Germany
FIRST PRODUCED: 1932
SUMMARY: The MG15 became one of the standard aircraft machine guns equipping most German combat aircraft at the start of World War II. The MG15 was developed by Rheinmetall in Borsig as a flexible-mount defense gun for bombers. The MG15 was air-cooled and recoil-operated and used Mauser 7.92mm ammunition. When the Luftwaffe no longer needed its 7.92mm aircraft machine guns later in the war (7.9mm was considered obsolete as aircraft armament and the smallest caliber guns were henceforth 13mm and 15mm machine guns), they were given to ground troops, mainly the field units of the Luftwaffe. Reworking the aircraft machine guns for the ground role began no later than 1942 and involved new sights, a shoulder rest, provision for mounting the weapon on the standard machine gun tripod or a bipod, spent cartridge deflector, and carrying sling.

MG34 (GPMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 7.62mm
WEIGHT: 26.5 lbs (12.1 kg) with bipod
LENGTH: 48" (1219mm)
RATE OF FIRE: 900 rpm
FEED: 50-round metal belt or 75-round twin drum
MUZZLE VELOCITY: 2,500 fps (762 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Germany
FIRST PRODUCED: 1934
SUMMARY: The Maschinengewehr-34 (MG34) was the main infantry support weapon of Adolf Hitler's army through the first half of World War II, as well as the main machine gun on tanks and other vehicles for the entire war. It is considered to be the first ever universal machine gun that could be used as a light machine gun from a bipod, as a sustained, heavy machine gun on a tripod, or as a tank or anti-aircraft gun. The MG34 was placed into service in 1935 and remained the official machine gun of the Wehrmacht until 1942, when it was replaced by the more reliable and cheaper MG42. The feed system was by either a 50-round metal belt or a 75-round twin drum that sat across the top of the gun like a saddle. It was an outstanding weapon and was finely tooled. Ironically, this was one of its greatest drawbacks because it was expensive and slow to manufacture, making it less suitable for wartime mass production. Its greatest asset was versatility and utility in multiple roles. As such, it set the trend for numerous later designs.

BREN GUN (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .303 (7.7mm)
WEIGHT: 22.12 lbs (9.95 kg)
LENGTH: 45.5" (1155mm)
RATE OF FIRE: 500 rpm
FEED: 29-round overhead box magazine
MUZZLE VELOCITY: 2,440 fps (744 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Great Britain
FIRST PRODUCED: 1937
SUMMARY: The Bren light machine gun had its origins in the Czech ZB 26. By the time it was put into production by the British in 1937, it had evolved into what many experts believe was one of the finest light machine guns ever made. The Bren revolutionized British and Australian tactics. It provided a light automatic weapon that could be carried on the move with the infantry, a capability that had never truly existed in the British Army. The Bren was also mounted on many different types of vehicles, and a variety of tripods were produced for just about every role. It served in France in 1939 and saw action in North Africa and Italy and the battle of Europe. Australian troops used the Bren in all theaters of war in which they served. There were three main wartime models with variants, but each used the basic gas-operated mechanism. The Mark 1 had an adjustable bipod, butt handle, and a drum rear sight. The Marks 3 and 4 appeared in 1944 and were shorter, lighter, and cheaper; there were other postwar changes. Most Bren guns were at first produced by Enfield, but lines were started up in Canada, Australia, and India. Output from all these lines was directed to all Allied and Commonwealth armies. Additionally, many guns were sent into Occupied Europe to equip the various underground organizations. It was uncomplicated, extremely reliable, and easily maintained. The Bren was used in Korea, Malaysia, and Vietnam. It was then converted to 7.62mm NATO ammunition, becoming the L4. It is still in service in militaries around the world.

BREDA MODELLO 30 (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 6.5mm
WEIGHT: 22.7 lbs (10.3 kg)
LENGTH: 48.5" (1,232mm)
RATE OF FIRE: 500 rpm
FEED: 20-round box magazine
MUZZLE VELOCITY: 2,034 fps (620 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Italy
FIRST PRODUCED: 1930
SUMMARY: The Breda light machine gun carried over the same unreliable 6.5mm round found in the Italian rifle. This was coupled with a low magazine capacity and several other unfortunate features to create a less than satisfactory LMG. Chief among the problems was the barrel change, which lacked a handle by which the gunner or assistant could remove the red-hot item without touching it. The side-mounted magazine was also an oddity. The box was hinged to turn through 90 degrees, placing it flat alongside the body. The lips were then facing the gunner, who would insert the ammunition from chargers before swinging the box back into place. It was a slow and laborious process, and the hinge proved susceptible to damage that rendered the weapon inoperable.

BREDA MODELLO 37 (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 8mm
WEIGHT: 41.9 lbs (19.3 kg)—gun; 41.17 lbs (18.8 kg)—tripod
LENGTH: 50" (1270mm)
RATE OF FIRE: 500 rpm
FEED: 20-round tray
MUZZLE VELOCITY: 2,600 fps (790 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Italy
FIRST PRODUCED: 1937
SUMMARY: The Breda 37 represented perhaps the best of the various small arms available to the Italian Army in World War II. The Breda still had limitations, however, key among which was the use of lubricated ammunition, which invited stoppages when mixed with the desert environment of North Africa. Another problem was in the feeding mechanisms. The Breda used a tray that was pulled through the mechanism, akin to the Hotchkiss strip-feed. The Breda 37 typified the overall lack of effective small arms in the Italian Army. Every weapon outside of the submachine gun class included several unnecessary and unwelcome features.

TYPE 92 (HMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 7.7mm
WEIGHT: 122 lbs (55.3 kg)
LENGTH: 45" (1160mm)
RATE OF FIRE: 450 rpm
FEED: 30-round magazine
MUZZLE VELOCITY: 2,350 fps (800 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Japan
FIRST PRODUCED: 1932
SUMMARY: The Type 92 was basically the same design as the M3 heavy machine gun, a World War I–vintage air-cooled gun. The Type 92 could use both the rimless and the rimmed 7.7mm round, and it was one of the most widely used weapons by the Imperial Japanese Army in World War II. The rate of fire was low, and it had a curious stuttering effect, causing it to be nicknamed the Woodpecker. Troops on the receiving end of this weapon never had a problem identifying it.

TYPE 93 (HMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .519 (13.2mm)
WEIGHT: 87 lbs (37.5 kg)
LENGTH: 95" (2413mm)
RATE OF FIRE: 450 rpm
FEED: 30-round box magazine
MUZZLE VELOCITY: 2,210 fps (674 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Japan
FIRST PRODUCED: 1933
SUMMARY: The Type 93 13mm was a copy of the Mitrailleuse Hotchkiss d 13mm 2 Modèle 1930. The Japanese placed this weapon on all the various mountings designed for it by the French. These included mobile and static antiaircraft mountings for both single- and dual-gun combinations, as well as a variety of tripod and bipod mounts. A variant mounted on a wheeled carriage was known as the Kyusan Shiki Shasai Jusan Miri Kikanju.

TYPE 96 (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 6.5mm
WEIGHT: 20 lbs (9 kg)
LENGTH: 41.5" (1055mm)
RATE OF FIRE: 550 rpm
FEED: 30-round detachable box magazine
MUZZLE VELOCITY: 2,300 fps (330 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Japan
FIRST PRODUCED: 1936

SUMMARY: The Type 96 Shiki Kikanju machine gun used rimmed cartridges, which needed oiling because they had no primary extraction; without oiling the case could not easily be withdrawn from the chamber. By the end of World War II, Japan had designed a Type 99 7.7mm light gun, far superior to these 6.5mm guns.

TYPE 99 (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 7.7mm
WEIGHT: 23 lbs (11.4 kg)
LENGTH: 46.75" (119 cm)
RATE OF FIRE: 850 rpm
FEED: 30-round magazine
MUZZLE VELOCITY: 2,350 fps (670 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Japan
FIRST PRODUCED: 1939
SUMMARY: When the Japanese Army adopted the Arisaka Type 99 7.7mm rifle, a 7.7mm light machine gun was also developed. The Type 99 is basically the same design as Type 96 and includes a monopod at the butt and a flash hider. The Type 99 needs no lubrication device and is very similar to the Type 96, though a little heavier. This weapon also haa reliability problems and, like the 6.5mm models, had to use slightly weaker ammo to cut down on jamming.

DShKM (HMG)

CALIBER: .50 (12.7mm)
WEIGHT: 78.7 lbs (35.7 kg)
LENGTH: 62.52" (1588mm)
RATE OF FIRE: 575 rpm
FEED: 50-round metal-link belt
MUZZLE VELOCITY: 2,821 fps (860 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Soviet Union
FIRST PRODUCED: 1938
SUMMARY: The DShKM (Stankoviy Degtyareva-Shpagina Krupnokaliberniy Modernizirovannly) was a heavy support or vehicle machine gun that was manufactured by the Kovrov machine-gun factory. Derived from the DK machine gun developed in 1929–1931, it was distinguished by a prominent rounded feed cover above the breech. The standard model was the 1938-pattern tripod mounted on wheels, which were detachable for use in stationary ground roles. Made in large numbers during World War II, these guns were used in many countries for many years after the war. A major modification was made in 1946 when K. Sokolov and Aleksandr Norov devised a modified feed that allowed disintegrating-link belts to be fed from either side of the receiver. This weapon was also mounted on a variety of Soviet tanks and armored personnel carriers. It saw extensive service in the Korean War and in Vietnam.

MACHINE GUN MODELS

1940s

MAT 49 (SMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 9mm
WEIGHT: 7.75 lbs (3.63 kg) without magazine
LENGTH: 18" (404mm) stock closed; 28" (720mm) stock open
RATE OF FIRE: 600rpm
FEED: 20- or 32- round box magazine
MUZZLE VELOCITY: 1,280 fps (390 mps)
ORIGINAL COUNTRY OF MANUFACTURE: France
FIRST PRODUCED: 1949

SUMMARY: The MAT 49 submachine gun was developed at the French state arms factory MAT (Manufacture Nationale d'Armes de Tulle) in the late 1940s and was adopted by the French Army in 1949. For some 30 years the MAT-49 was widely used by the French military in campaigns, including Indochina and Algeria. The MAT-49 is no longer used by the French Army but still can be seen in the hands of the police and gendarmerie.

MP40 (SMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 9mm
WEIGHT: 8.7 lbs (3.97 kg)
LENGTH: 32.75" (83.2 cm) with stock extended
RATE OF FIRE: 500 rpm
FEED: 25- or 32-round box magazine
MUZZLE VELOCITY: 1,250 fps (381 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Germany
FIRST PRODUCED: 1940
SUMMARY: The MP40 machine pistol was based on the prewar MP38, modifying the earlier design to make it more suitable for mass production; more than 1 million were produced during the war. Its folding metal stock made it compact and easy to carry, even in cramped quarters; its startling staccato bursts of fire shattered the silence in many Normandy hedgerows. The MP40 won the admiration of Allied soldiers, who often referred to the MP40 as the Schmeisser, despite the fact that firearms engineer Hugo Schmeisser, designer of the Bergmann MP18 submachine gun in 1918, was not involved in the design of either the MP38 or the MP40.

MG42 (GPMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 7.92mm
WEIGHT: 25.25 lbs (11.5 kg) with bipod
LENGTH: 48" (1219mm)
RATE OF FIRE: 1200 rpm
FEED: 50-round or 250-round link belt
MUZZLE VELOCITY: 2,478 fps (755 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Germany
FIRST PRODUCED: 1942
SUMMARY: The MG42 was designed during World War II as a replacement for the multipurpose MG34, which was less than suitable for wartime mass production and was also somewhat sensitive to fouling and mud. It was manufactured in great numbers by companies like Grossfuss, Mauser-Werke, Gustloff-Werke, Steyr-Daimler-Puch, and several others. It is estimated that more than 400,000 MG42s were manufactured during the war, and it was undoubtedly one of the best machine guns of World War II. It was designed to be reliable and cheap to manufacture; the design was so effective that it is still in production in more or less modified form in many countries.

STEN (SMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 9mm Parabellum
WEIGHT: 6.5 lbs (2.95 kg) unloaded
LENGTH: 30" (762mm)
RATE OF FIRE: 550 rpm
FEED: 32-round box magazine
MUZZLE VELOCITY: 1,250 fps (381mps)
ORIGINAL COUNTRY OF MANUFACTURE: Great Britain
FIRST PRODUCED: 1941
SUMMARY: In early 1941 a prototype of what became the Sten submachine gun was put forth by the Royal Small Arms Factory in England, inspired by captured German MP40s. The Sten is a simply built weapon, manufactured from just 47 parts, mainly stamped from steel and welded, sweated, pressed, or riveted together. The only machined parts are the bolt and barrel. The Sten's compact size, simplicity of manufacture, and ease of dismantling (and hiding) made it a favorite among resistance groups on the continent. In addition, it could use captured German 9mm ammunition. The Sten Mark V was introduced for airborne troops.

PPSh41 (SMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 7.62mm
WEIGHT: 8 lbs (3.6 kg)
LENGTH: 33" (840mm)
RATE OF FIRE: 900 rpm
FEED: 71-round drum magazine
MUZZLE VELOCITY: 1,600 fps (490 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Soviet Union
FIRST PRODUCED: 1942
SUMMARY: Designed by Georgiy Shpagin, a career Red Army officer who would rise to the rank of lieutenant general, the PPSh41 submachine gun was produced in great numbers to help the Soviets combat the German invasion. It became the Red Army's primary weapon, and it is estimated that well over 5 million PPSh41s were produced between 1942 and 1945. It later saw service in many Soviet satellite and client states under a variety of different designations and variants. It saw extensive service with both the North Korean and Chinese armies in the Korean War and was also used by the Vietcong in limited numbers during the Vietnam War.

SGM (HMG)

CALIBER: 7.62mm
WEIGHT: 30 lbs (13.6 kg)
LENGTH: 44" (1120mm)
RATE OF FIRE: 650 rpm
FEED: 250-round fabric belt
MUZZLE VELOCITY: 2,790 fps (850 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Soviet Union
FIRST PRODUCED: 1943
SUMMARY: In the Red Army in 1942, a replacement was needed for the obsolete Model 1910. It was developed by the team led by P. M. Goryunov at the Kovrov machine-gun plant. Less than a year later, a new machine gun had been sent to the front for army trials, and in May 1943 it was adopted as a 7.62mm mounted machine gun system Gorjunov (SG-43). After the end of World War II, the SG-43 was modernized several times, becoming the SGM. Another version was produced as a tank gun (the SGMT) with an electric trigger, and as an armored car gun (the SGMB) with special mountings. It was used by the Soviet Army until the mid-1960s, when it was gradually replaced by the first Russian universal machine gun, the PK. The SGM was widely exported to Soviet-friendly countries and regimes and was also manufactured in some countries like China.

CARL GUSTAV M45 (SMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 9mm Parabellum
WEIGHT: 7 lbs, 14 oz (3.59 kg)
LENGTH: 31.8" (808mm) stock extended; 21.7" (552mm) stock retracted
RATE OF FIRE: 600 rpm
FEED: 36-round box magazine
MUZZLE VELOCITY: 1,345 fps (410 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Sweden
FIRST PRODUCED: 1945
SUMMARY: This weapon, also popularly known as the Swedish K, was a result of the realization by the Swedish military during World War II that its military equipment was slipping into obsolescence. The state arms factory, Carl Gustav, set out to remedy the situation. By 1945, the factory had produced a design for a submachine gun that was cheap and simple to manufacture. It is a robust and simple weapon and is still used by the Swedish and other forces.

JOHNSON MODEL 1941 (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 0.30" (7.62mm)
WEIGHT: 14.3 lbs (6.45 kg)
LENGTH: 42" (1067mm)
RATE OF FIRE: variable 300–900 rpm
FEED: 20-round box magazine
MUZZLE VELOCITY: 2,800 fps (835 mps)
ORIGINAL COUNTRY OF MANUFACTURE: United States
FIRST PRODUCED: 1941
SUMMARY: The Johnson Light Machine Gun was derived from the earlier Johnson Automatic Rifle. It was a very light weapon with many unusual features. It had a variable rate of fire, used a recoil-operated mechanism that fired from a closed bolt for semiauto, and had an open bolt for automatic fire. It was ordered by the Dutch government for use in the Dutch East Indies but was never delivered because of the Japanese invasion. Some were issued to the U.S. Marines and Special Service units. It soon proved to be a troublesome weapon, so large orders were not made. There are reports that Marines threw the weapon away in action and used other weapons. For all its faults, the Johnson had many novel features that were incorporated into later machine-gun designs.

M3A1 (SMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .45 ACP
WEIGHT: 8.25 lbs (3.7 kg)
LENGTH: 22.75in (580mm) with stock retracted
RATE OF FIRE: 450 rpm
FEED: 30-round box magazine
MUZZLE VELOCITY: 870 fps (285mps)
ORIGINAL COUNTRY OF MANUFACTURE: United States
FIRST PRODUCED: 1942
SUMMARY: The M3 Grease Gun was a lightweight, all-metal, blowback-operated submachine gun with a selective-fire capability. Just like the Sten, it was designed with ease of manufacture, and not the soldier's approval, in mind. The original design suffered from several problems, not the least of which were associated with the cocking mechanism. Revisions were made and the result was the M3A1, which remained in service in the U.S. Army for more than 20 years.

MACHINE GUN MODELS

1950s

FN MAG (GPMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .30 (7.62mm)
WEIGHT: 24 lbs (11 kg) with butt and bipod
LENGTH: 49.2" (1260mm)
RATE OF FIRE: 800–1000 rpm (variable)
FEED: disintegrating metal-link belt
MUZZLE VELOCITY: 840 mps
ORIGINAL COUNTRY OF MANUFACTURE: Belgium
FIRST PRODUCED: 1957
SUMMARY: The MAG is a GPMG manufactured by Fabrique Nationale (FN) of Herstal, Belgium. It is air-cooled, gas-operated, and has a wooden butt. It has a bipod but can be used with the FN 360 tripod. There are variants, including single and double aircraft mounts, a coaxial version for use alongside the main turret gun in tanks and armored vehicles, and an antiaircraft version. The MAG has been sold worldwide in huge quantities; FN had sold more than 150,000 by 1979, and many others have been made under license in Britain, Sweden, and the United States.

ZB VZ\52\57 (LMG)

CALIBER: .30 (7.62mm)
WEIGHT: 18.53 lbs (7.95 kg) with bipod
LENGTH: 40.98" (1041mm)
RATE OF FIRE: 900 rpm
FEED: 100-round belt or detachable 25-round box magazine
MUZZLE VELOCITY: 2,444 fps (745 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Czechoslovakia
FIRST PRODUCED: 1952
SUMMARY: The vz\52 light machine gun is based on the ZB vz\30. It traces its ancestry to the famous Czech ZB vz\26 machine gun of the pre–World War II period. The vz\52 is a gas-operated, selective-fire, belt- or magazine-fed machine gun. The weapon's feed system is so designed that it can take metallic belts or box magazines interchangeably without modification. Box magazines are inserted from the top, and the magazine port has a dust cover to protect the feed unit from elements when using belt-feed.

MADSEN-SAETTER (GPMG)

CALIBER: .30 (7.62mm)
WEIGHT: 23\8 lbs (10.8 kg) with bipod and light barrel
LENGTH: 45.88" (1165mm)
RATE OF FIRE: 650-1,000 rpm
FEED: metal-link belt with 49 rounds
MUZZLE VELOCITY: 835 mps
ORIGINAL COUNTRY OF MANUFACTURE: Denmark
FIRST PRODUCED: 1952
SUMMARY: The Madsen-Saetter is a Danish GPMG made by Dansk Industri Syndikat, Copenhagen. It is gas-operated and fires from the open bolt position, which serves to minimize the chances of cook-off. It was designed so that by changing the bolt and the barrel it could accommodate any caliber from 6mm to 8mm. It takes a belt feed, has an adjustable rate of fire of 650–1000 rpm and can take a tripod or bipod mounting.

AAT 52 (GPMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 7.5mm (7.62mm)
WEIGHT: 21 lbs (9.97 kg)
LENGTH: 45" (1,145mm)—butt extended; 38.5" (980mm)—butt retracted
RATE OF FIRE: 700–900 rounds per minute (rpm)
FEED: continuous metal link
MUZZLE VELOCITY: 2,757 feet per second (fps) (840 meters per second [mps])
ORIGINAL COUNTRY OF MANUFACTURE: France
FIRST PRODUCED: 1952
SUMMARY: The Arme Automatique Transformable Model 52 designed by MAS (Manufacture Nationale d'Armes) in the early 1950s was adopted by the French military, initially in 7.5mm French and later converted to fire 7.62mm NATO ammunition. The AAT 52 has a delayed-blowback action with belt feeding. The barrel is quick-changeable and has a fluted chamber to assist extraction. The basic version is issued with a short (light) barrel to be used on a bipod. When used on a tripod mount, a longer and heavier barrel can be installed.

STERLING MARK 4 SUBMACHINE GUN (SMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 9mm
WEIGHT: 6 lbs (2.72 kg)
LENGTH: 27" (690mm) with butt extended
RATE OF FIRE: 550 rpm
FEED: 34-round curved box magazine
MUZZLE VELOCITY: 1,280 fps (390 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Great Britain
FIRST PRODUCED: 1954
SUMMARY: Adopted for British forces in 1954 as the L2A3, the Sterling has been sold to well over 70 military and defense forces throughout the world. It is reliable and efficient under a wide range of conditions. The weapon was also manufactured in Canada and India under license.

UZI (SMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 9x19mm Parabellum
WEIGHT: 8.25 lbs (3.75 kg)
LENGTH: 18.5" (470mm)—stock retracted; 25.60" (650mm) stock extended
RATE OF FIRE: 600 rpm
FEED: 25- or 32-round box magazine
MUZZLE VELOCITY: 1,312 fps (400 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Israel
FIRST PRODUCED: 1951
SUMMARY: Designed by Major Uziel Gal of the Israeli Defense Forces, this submachine gun has been in continuous production since 1951. It has been adopted by many countries throughout the world for both military and police use. There are also two smaller models, the Mini-Uzi and the Micro-Uzi, but their ballistic characteristics are somewhat different because of the smaller sizes. The Uzi and its variants are likely the most popular submachine guns in the world, being manufactured in great numbers, probably more than 10 million.

RPD (LMG)

CALIBER: .30 (7.62mm)
WEIGHT: 15.65 lbs (7.1 kg) with bipod
LENGTH: 41" (1037mm)
RATE OF FIRE: 700 rpm
FEED: 100-round metal-link belt
MUZZLE VELOCITY: 2,412 fps (735 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Soviet Union
FIRST PRODUCED: 1953
SUMMARY: The RPD (Ruchnoi Pulemet Degtyareva Modernizirovanniy) was a light support machine gun manufactured by the Kovrov machine-gun factory and possibly also in Tula. The RPD had a reciprocating charging handle and a back-sight windage adjustment. It was fed by a metal-link belt that was normally contained in a lightweight drum suspended beneath the receiver. The RPD was made in vast quantities and was used extensively in the Soviet Army and Warsaw Pact forces. The Chinese variant, the Type 56-1, was used extensively by communist forces in the Korean War; both versions were used in Southeast Asia.

M61 VULCAN (AUTO CANNON)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 20mm
WEIGHT: 300 lbs (136 kg)—gun only
LENGTH: 6' (1.83 m)
RATE OF FIRE: up to 6,000 rpm
FEED: disintegrating metal-link belt or linkless feed
MUZZLE VELOCITY: 2,200 fps (670 mps)
ORIGINAL COUNTRY OF MANUFACTURE: United States
FIRST PRODUCED: 1956
SUMMARY: Built around the Gatling principle, the M61 resulted from Project Vulcan, which was intended to develop a super-rapid firing weapon for the U.S. Air Force. Experiments conducted by General Electric resulted in several electric-drive machine guns with multiple barrels. In 1956, the six-barrel 20mm T171 was officially adopted as the M61. This gun could fire at the rate of 4,000–6,000 rpm. This achievement was possible due to the fact that the gun had multiple barrels, and the rate of fire per one barrel was about 1,000 rpm, preventing overheating. The M61 became the main aircraft gun for the U.S. Air Force and also was used on M161 and M163 Vulcan ground antiaircraft gun mounts.

M60 MACHINE GUN (GPMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .30 (7.62mm)
WEIGHT: 23.17 lbs (10.51 kg) with bipod
LENGTH: 43.5" (1105mm)
RATE OF FIRE: 550 rpm
FEED: metal-link belt
MUZZLE VELOCITY: 2,838 fps (865 mps)
ORIGINAL COUNTRY OF MANUFACTURE: United States
FIRST PRODUCED: 1956
SUMMARY: The M60 machine gun was adopted by the United States Army in 1956, but full production did not begin until 1960. It was developed to replace all the Browning machine guns excepting vehicle guns. It used a gas mechanism derived from the Lewis gun and the MG42. The M60 was used by U.S. forces during the Vietnam War. It was made in large numbers and saw service in the armed forces of more than 30 nations. The M60 has been adapted to several variants, including those for use on helicopter mounts and another for armored vehicles. The M60E2 has been the U.S. Army standard since 1977.

MACHINE GUN MODELS

1960s

STEYR MPI 69 (SMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical

CALIBER: 9x19mm Parabellum
WEIGHT: 6 lbs, 14 oz (3.13 kg)
LENGTH: 26.38" (670mm) stock extended; 18.3" (465mm) stock retracted
RATE OF FIRE: 550 rpm
FEED: 25- or 32-round magazine
MUZZLE VELOCITY: 1,250 fps (381 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Austria
FIRST PRODUCED: 1969
SUMMARY: The Steyer Mpi 69 submachine gun was developed by Steyr-Mannlicher AG. It was a blowback-operated, selective-fire weapon. The selection of semiauto or auto fire was achieved by pressure on the trigger; light pressure produced semiauto, while heavier pressure brings in a locking device that brought down the sear and permitted automatic fire. It was made from stamped steel and nylon. Steyr manufactured a slightly modified variant, called the MPi, with the rate of fire increased to nearly 700 rpm.

MP5 (SMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 9mm Parabellum
WEIGHT: 5.62 lbs (2.55 kg)
LENGTH: 19.3" (490mm)—stock retracted; 26" (660mm) stock extended
RATE OF FIRE: 800 rpm
FEED: 15- or 30-round curved box magazine
MUZZLE VELOCITY: 1,312 fps (400 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Germany
FIRST PRODUCED: 1964
SUMMARY: Produced by Heckler & Koch, the MP5 submachine gun employs the same roller-lock, two-piece breechblock system perfected in its G3 rifle. Firing from the closed bolt, the MP5 is vastly more accurate than the average weapon of its class. The MP5 comes in variants, including the MP5A2 with a rigid plastic stock, the MP5A3 with a telescoping metal stock, the MP5SD silenced version, and the compact MP5K. The MP5 is a favorite with special forces units such as the British Special Air Service.

HECKLER & KOCH HK11 (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .30 (7.62mm)
WEIGHT: 13.67 lbs (6.2 kg) without bipod or magazine
LENGTH: 40.16" (1020mm)
RATE OF FIRE: 850 rpm
FEED: 20-round detachable box magazine or 80-round dual drum
MUZZLE VELOCITY: 2,559 fps (780 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Germany
FIRST PRODUCED: 1965

SUMMARY: The HK11 is a light support machine gun manufactured by Heckler & Koch of Oberndorf am Neckar. It is basically a German G3 rifle with a bipod that can fire semiauto or auto. The HK11 is such a sound design that it is manufactured under license in more than 14 countries. The HK11E (shown) is a variant capable of sustained automatic fire by the addition of a belt-feed unit.

MG3 (GPMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 7.62mm NATO
WEIGHT: 23.35 lbs (11.5 kg)
LENGTH: 48" (1220mm)
RATE OF FIRE: 750–1350 rpm selectable
FEED: linked belt
MUZZLE VELOCITY: 2,700 fps (825 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Germany
FIRST PRODUCED: 1968
SUMMARY: The MG3 is one of the most popular and universal machine guns ever. The MG3 is a modified version of the MG42, German World War II–era machine gun, adapted to fire 7.62mm NATO rounds instead of the 7.92mm Mauser round. It started as MG42\59 in 1959, and since 1968 the MG3 has been in mass production. The MG3 has been exported to Chile, Denmark, Italy, Pakistan, Saudi Arabia, Iran, Norway, Austria, Portugal, and Turkey. MG3 clones are built in Yugoslavia and other countries.

TYPE 67 (GPMG)

CALIBER: .30 (7.62mm)
WEIGHT: 25.79 lbs (11.7 kg) without tripod
LENGTH: 52.95" (1345mm)
RATE OF FIRE: 650 rpm
FEED: 50-round belt drum or 250-round belt box
MUZZLE VELOCITY: 865 mps
ORIGINAL COUNTRY OF MANUFACTURE: China
FIRST PRODUCED: 1967
SUMMARY: The Type 67 is a light GPMG that is gas-operated and has automatic fire only. The feed system is an adaptation of the prewar Chinese Type 24 Maxim, and most of the other features of the gun were taken from other guns. It is widely used by Chinese militia units.

TYPE 62 (GPMG)

CALIBER: .30 (7.62mm)
WEIGHT: 23.59 lbs (10.7 kg) with bipod
LENGTH: 47.24" (1200mm)
RATE OF FIRE: 600 rpm
FEED: metal-link belt
MUZZLE VELOCITY: 2,805 fps (855 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Japan
FIRST PRODUCED: 1962
SUMMARY: The Type 62 GPMG was manufactured by Nittoku Heavy Industries of Tokyo. It has a shoulder stock and an odd-looking pistol grip with a heel that projects from the under edge of the receiver. There is a coaxial tank-gun variant of the Type 62 called the Type 74.

PK (GPMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 7.62mm
WEIGHT: 18.5 lbs (8.4 kg)
LENGTH: 45.5" (1160mm)
RATE OF FIRE: 710 rpm
FEED: 100-, 200-, or 250-rd belt
MUZZLE VELOCITY: 2,700 fps (825 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Soviet Union
FIRST PRODUCED: 1961
SUMMARY: The 7.62mm PK (Pulemyot Kalashnikova) was the standard GPMG of Soviet and Warsaw Pact forces. It is a gas-operated, belt-fed, sustained-fire weapon. The Soviets based its design on the Kalashnikov assault rifle. Notable differences are the gas cylinder below the barrel, with the hollow-frame stock resembling that of the SVD, a sniper cutaway rifle with a stock. There are variants of the PK, which can be used as a heavy machine gun and both externally and as a coaxial machine gun in tanks and armored fighting vehicles.

RPK (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 7.62mm
WEIGHT: 10.5 lbs (4.75 kg)
LENGTH: 41" (1040mm)
RATE OF FIRE: 600 rpm
FEED: 40-round box or 75-round drum magazines, as well as standard AK 47 type 30-round box magazine
MUZZLE VELOCITY: 2,400 fps (730mps)
ORIGINAL COUNTRY OF MANUFACTURE: Soviet Union
FIRST PRODUCED: 1961
SUMMARY: The RPK Ruchnoi Pulemet Kalashnikova (Kalashnikov Light Machine Gun) was developed as a light support weapon for the infantry squad. It has been officially replaced in service by RPK-74 but in fact is still in use with many second-line and noninfantry troops, as well as with other paramilitary organizations in Russia and other states. Basically, the RPK is an AK47 (AKM) assault rifle with sturdier receiver, heavier and longer nondetachable barrel, and a recontoured wooden buttstock. The paratrooper version of the RPK, the RPK-S, has a side-folding wooden buttstock.

GAU-2B MINIGUN (AUTO CANNON)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 7.62mm
WEIGHT: 35.93 lbs (16.3 kg)—gun only
LENGTH: 31.57" (802mm)
RATE OF FIRE: up to 6000 rpm
FEED: disintegrating metal-link belt or linkless feed
MUZZLE VELOCITY: 920 mps
ORIGINAL COUNTRY OF MANUFACTURE: United States
FIRST PRODUCED: 1962
SUMMARY: Derived from the Gatling gun by way of experiments beginning shortly after the end of World War II, the GAU-2B minigun, designated M134 by the U.S. Army, consisted of a cluster of six barrels powered by an external power source. The minigun was adapted for use in a chin turret on the AH-1G Cobra attack helicopter, into a flexible gun mounted in the doors of UH-1 Huey and HH-3 Jolly Green Giant helicopters, and twin side mounts that replaced the four M60C guns on the UH-1B\C gunship helicopters.

STONER 63 (MMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 5.56mm
WEIGHT: 12.5 lbs (5.65 kg)
LENGTH: 40.25" (1022mm)
RATE OF FIRE: 700 rpm
FEED: 30-round magazine
MUZZLE VELOCITY: 3,249 fps (990 mps)
ORIGINAL COUNTRY OF MANUFACTURE: United States
FIRST PRODUCED: 1963
SUMMARY: The Stoner 63 5.56mm machine gun was developed by Eugene Stoner, whose objective was a modular, gas-operated, selective-fire weapon that could be made into a rifle, a carbine, a belt-fed machine gun (right or left feed), a squad automatic weapon with top feed (similar to the British Bren), and a solenoid-fired fixed machine gun for vehicle use. The Stoner Weapon System saw use in Vietnam by U.S. Navy SEALs. Most SEAL Stoners were of the belt-fed, LMG variety such as the Stoner 63A Commando (with shortened barrel). The Army had two different versions made for evaluation by special forces units as the XM-207 in early 1970. If there was any criticism of the Stoner, it was that it had a lot of small parts and required a lot of care in order to perform. Stoner production ceased altogether by the end of 1971.

MACHINE GUN MODELS

1970s

HECKLER & KOCH HK21 (GPMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .30 (7.62mm)
WEIGHT: 16.09 lbs (7.3 kg) without bipod
LENGTH: 40.18" (1020mm)
RATE OF FIRE: 850 rpm
FEED: metal-link belt
MUZZLE VELOCITY: 2,625 fps (800 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Germany
FIRST PRODUCED: 1970
SUMMARY: The HK21, manufactured by Heckler & Koch of Oberndorf am Neckar, is a GPMG that is little more than a variant of the HK11 light machine gun, adapted to feed from a belt instead of a box magazine. It has a pistol grip and a bipod.

HECKLER & KOCH HK21A1 (GPMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 7.62mm NATO
WEIGHT: 17.9 lbs (8 kg)
LENGTH: 40.5" (1028.7mm)
RATE OF FIRE: 900 rpm
FEED: belt fed
MUZZLE VELOCITY: 2,625 fps (800 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Germany
FIRST PRODUCED: 1975
SUMMARY: The HK21A1, manufactured by Heckler & Koch of Oberndorf am Neckar, is the latest development of the HK21, which has been in military service for years. It is a light GPMG designed to provide firepower to the infantry squad without adding to logistical loads. The HK21A1 is normally configured with a bipod, but there are special mounts for light vehicle and antiaircraft use. The HK21A1 has been purchased by African and Asian armies. The most recent version of the HK21 is the HK21E, which includes technical modifications that resulted in a more efficient and durable weapon.

L86 LSW (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .223 (5.56mm)
WEIGHT: 15.17 lbs (6.88 kg) with bipod and loaded magazine
LENGTH: 35.4" (900mm)
RATE OF FIRE: 775 rpm
FEED: 30-round detachable box magazine
MUZZLE VELOCITY: 3,182 fps (970 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Great Britain
FIRST PRODUCED: 1976
SUMMARY: The L86 Light Support Weapon was manufactured by Royal Ordnance, Nottingham, UK. It was a gas-operated, selective-fire weapon used to provide automatic fire support to the infantry squad. It lacked a detachable barrel and consequently could not sustain fire for protracted periods.

INGRAM MODEL 10 (SMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 9mm Parabellum
WEIGHT: 6 lbs (2.72 kg)
LENGTH: 11.73" (298mm)—stock retracted; 22" (559mm)—stock extended
RATE OF FIRE: 1050 rpm
FEED: 32-round box magazine
MUZZLE VELOCITY: 1,200 fps (380 mps)
ORIGINAL COUNTRY OF MANUFACTURE: United States
FIRST PRODUCED: 1970
SUMMARY: Gordon Ingram developed this submachine gun for the Military Armament Corporation in 1970. The Model 10 was extremely compact and built of steel pressings, no doubt emulating the Uzi. Small quantities of the Model 10 were sold to several countries, but the company met financial troubles and went into liquidation. Since then, many companies have manufactured exact copies or slightly modified clones of both Model 10 and Model 11 (the smaller version of M10, in .380ACP 9x17mm Short). The Model 10 or its variants were adopted by some special forces units and police units in the United States and several other countries.

UIRAPURU (GPMG)

CALIBER: .30 (7.62mm)
WEIGHT: 28.7 lbs (13 kg) with bipod
LENGTH: 51.18" (1300mm)
RATE OF FIRE: 700 rpm
FEED: metal-link belt
MUZZLE VELOCITY: 2,789 fps (850 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Brazil
FIRST PRODUCED: 1977
SUMMARY: The Uirapuru is a general-purpose aircraft or vehicle machine gun. It was manufactured by the Mekanika Industria e Comerciao Ltda in Rio de Janeiro. The prototype for this weapon was developed in 1970, but it took several years to perfect the design, which is distinctive because of its long, slender, tubular appearance and the presence of a prominent flash suppressor\muzzle break. It can be fitted with a wooden butt and mounted on a bipod to serve as a light infantry support gun. It can also be mounted on a tripod for sustained fire or mounted coaxially with the main armament of a tank

BERETTA AS-70 (LMG)

CALIBER: .223 (5.56mm)
WEIGHT: 11.7 lbs (5.3 kg) with bipod
LENGTH: 37.6" (955mm)
RATE OF FIRE: 670 rpm
FEED: 40-round detachable box magazine
MUZZLE VELOCITY: 3,182 fps (970 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Italy
FIRST PRODUCED: 1979
SUMMARY: The AS-70 was manufactured by Pietro Berretta SpA, Gardone Val Trompia. It is an adaptation of Beretta's 5.56mm assault rifle to provide a light machine gun. The AS-70\78 was moderately successful, but the detachable barrel and the resultant alterations in the design of the receiver lost the important commonality of parts with the assault rifle. Consequently, Beretta replaced the 70\78 with a simpler design.

HUGHES CHAIN GUN M230 (AUTO CANNON)

CALIBER: 30mm
WEIGHT: 123.2 lbs (55.88 kg)
LENGTH: 64.48 in (1637.79 mm)
RATE OF FIRE: variable up to 600 rds\min
FEED: belt-fed
MUZZLE VELOCITY: 2,650 fps (807.72 mps)
ORIGINAL COUNTRY OF MANUFACTURE: United States
FIRST PRODUCED: 1976
SUMMARY: This mechanical machine gun manufactured by Hughes Helicopters of Culver City, California, utilizes a unique chain firing system. This mechanism uses a loop of commercial roller chain that lies on the bottom of the receiver and is driven round by a gear. An electric motor drives the chain, which moves the bolt forward and backward. The result is one of the most reliable and smoothest operating machine guns in existence. It became the main armament for the AH-64 Apache attack helicopter, in which it was mounted in a chin pod and controlled by a computerized link to the pilot's helmet. The Hughes chain gun has also been manufactured in 25mm caliber as the M252 Bushmaster, which was adopted as the main armament for the M2\M3 Bradley Fighting Vehicle. Another version, the EX-34, was developed in 7.6mm caliber; it was adopted as the coaxial machine gun for the M1 Abrams and the British Challenger II tanks and the Warrior infantry fighting vehicle.

MACHINE GUN MODELS

1980s AND AFTER

STEYR AUG-LMG (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .223 (5.56mm)
WEIGHT: 8.88 lbs (4.03 kg) with bipod
LENGTH: 35.43" (900mm)
RATE OF FIRE: 750 rpm
FEED: detachable 30- or 42-round box magazine
MUZZLE VELOCITY: 3,199 fps (975 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Austria
FIRST PRODUCED: 1987
SUMMARY: Produced by Steyr-Mannlicher GmBH, the AUG-LMG, a light support machine gun, is a heavy-barrel version of the 5.56mm AUG standard assault rifle. It has a large synthetic trigger guard molded as an integral part of the futuristic butt. It also has a folding grip on the fore end and a bipod fitted to the muzzle. It is gas-operated and has a selective rate of fire.

F89 (LMG)

CALIBER: .223 (5.56mm)
WEIGHT: 15.21 lbs (6.9 kg) with bipod
LENGTH: 40.94" (1040mm)
RATE OF FIRE: 500 rpm
FEED: 200-round metal-link belt or detachable 30-round box magazine
MUZZLE VELOCITY: 3,199 fps (975 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Australia
FIRST PRODUCED: 1989
SUMMARY: The F89, manufactured by the Lithgow small-arms factory in New South Wales, is a variant of the Belgian Fabrique Nationale Minimi with a few changes to suit Australian production techniques. It is gas-operated with rotating bolt. One distinguishing characteristic is the solid slab-type synthetic component butt, which differs from the tube design associated with the Belgian prototype.

MINIMI (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .223 (5.56mm)
WEIGHT: 14.25 lbs (6.83 kg) with bipod
LENGTH: 40.8" (1040mm)
RATE OF FIRE: 500 rpm
FEED: 200-round metal-link belt or detachable 30-round box magazine
MUZZLE VELOCITY: 3,035 fps (925 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Belgium
FIRST PRODUCED: 1982
SUMMARY: The Minimi is a light support machine gun manufactured by Fabrique Nationale (FN) in Herstal, Belgium. It was designed as a partner to the 5.56 FNC automatic rifle and was intended to share a commonality of parts with that weapon. The Minimi is gas-operated with selective fire. A unique feature of the weapon is that it can handle conventional disintegrating-link belted ammunition or a 30-round box magazine without any adaptation. There is also a short-barreled version intended for paratroops, vehicle-borne personnel, and anyone else who requires a more compact weapon. Additionally, there is a vehicle variant with an electrically operated solenoid trigger system. The Minimi has been adopted worldwide, and copies have been made in several countries (e.g., by Daewoo in Korea).

FABRIQUE NATIONALE P90 (SMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 5.7x28mm
WEIGHT: 5 lb 9 oz (2.54 kg)
LENGTH: 19.68" (500mm)
RATE OF FIRE: 900 rpm
FEED: 50-round box magazine
MUZZLE VELOCITY: 2,345 fps (715 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Belgium
FIRST PRODUCED: 1988
SUMMARY: This unusual submachine gun was developed by Fabrique Nationale (FN) to arm the two-thirds of an army whose principle duty is something other than close combat. The P90 is a blow-back-operated, selective-fire weapon that fires a new round with enhanced penetration—the SS190. It is fed from 50-round box magazines made from translucent polymer. The P90 is generally categorized in the new type of weapons described as Personal Defense Weapons. By the late 1990s, the P90 was in service in 15 countries and under evaluation in others.

HECKLER & KOCH HK23 (GPMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .223 (5.56mm)
WEIGHT: 19.8 lbs (8.7 kg) with bipod
LENGTH: 40.55" (1030mm)
RATE OF FIRE: 800 rpm
FEED: metal-link belt
MUZZLE VELOCITY: 3,002 fps (915 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Germany
FIRST PRODUCED: Early 1980s
SUMMARY: The original HK23, manufactured by Heckler & Koch of Oberndorf am Neckar, was a GPMG that was simply the small-caliber version of the 7.62mm HK21A. A later model, the HK23E, was modified to use an adaptor that would accept the standard G3-type box magazine.

NEGEV (LMG)

CALIBER: .223 (5.56mm)
WEIGHT: 15.87 lbs (7.2 kg) with bipod
LENGTH: 40.16" (1020mm)—butt extended; 30.71" (780mm)—butt folded
RATE OF FIRE: 725 rpm and 875 rpm (selectable)
FEED: metallic-link belt
MUZZLE VELOCITY: 950 mps
ORIGINAL COUNTRY OF MANUFACTURE: Israel
FIRST PRODUCED: 1996
SUMMARY: The Negev light support machine gun was inspired by the Belgian FN Minimi but adapted to the specific needs of the Israeli Defense Forces. The result is a weapon that is more reliable than the FN in adverse field situations and harsh desert conditions. The Negev has a folding butt and an integral mount on the receiver for optical, electro-optical, or thermal imaging sights. The fire selector has three positions—auto, semiauto, and safe. The Negev is also manufactured in a commando variant with a shorter barrel.

DAEWOO K3 (LMG)

CALIBER: .223 (5.56mm)
WEIGHT: 15.1 lbs (6.85kg) with bipod
LENGTH: 40.55" (1030mm)
RATE OF FIRE: 850 rpm
FEED: 30-round detachable box magazine or 200-round belt
MUZZLE VELOCITY: 3,150 fps (960 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Korea
FIRST PRODUCED: 1990
SUMMARY: The K3, manufactured by Daewoo Precision Industries of Seoul, is basically a copy of the Belgian Fabrique Nationale (FN) Minimi. Changes have been made to the design of the butt and fore end, but the box magazine adaptor has been retained beneath the feed block and the operating system remains largely unaltered.

CIS 50 (HMG)

CALIBER: .50 (12.7mm)
WEIGHT: 66.14 lbs (30kg)—without mount
LENGTH: 65.74" (670mm)
RATE OF FIRE: 500 rpm
FEED: metal-link belt
MUZZLE VELOCITY: 2,920 fps (890 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Singapore
FIRST PRODUCED: 1988
SUMMARY: The CIS 50 is a heavy support machine gun manufactured by Chartered Industries of Singapore. It is Singapore's answer to the venerable Browning M2. It can be adapted to fulfill differing roles.

CETME 5.56 (LMG)

CALIBER: .223 (5.56mm)
WEIGHT: 13.89 lbs (6.3 kg)
LENGTH: 38" (970mm)
RATE OF FIRE: 1000 rpm
FEED: Belt fed
MUZZLE VELOCITY: 2,871 fps (875 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Spain
FIRST PRODUCED: 1982
SUMMARY: This Spanish machine gun was manufactured by Centro de Estudios Technicos de Materiales Especiales of Madrid. The CETME design office and research center was set up by the Spanish government in the early 1950s, and much of the original staff were refugees from Germany, where they had been employed in a similar capacity before and during World War II. As a result one can trace designs back to the Mauserwerke of 1943–1944, directly influenced by the famous MG42.

CIS ULTIMAX M100 MARK III (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .223 (5.56mm)
WEIGHT: 18.14 lbs (5.5 kg)- with bipod and empty drum magazine
LENGTH: 12.3 lbs (1024mm)
RATE OF FIRE: 500 rpm
FEED: detachable 100-round drum or 30-round box magazine
MUZZLE VELOCITY: 3,182 fps (970 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Singapore
FIRST PRODUCED: 1982
SUMMARY: Advertised as the lightest of all light machine guns designed at the outset for one-man operation, the Ultimax is a lightweight infantry support weapon manufactured by Chartered Industries of Singapore. Despite its light weight, it is very controllable thanks to its recoil-absorbing action.

AKS-74U (SMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: 5.45x39.5mm
WEIGHT: 5 lbs, 14 oz (2.7 kg)
LENGTH: 19.29" (489.96mm)—stock retracted; 28.74" (730mm)—stock extended
RATE OF FIRE: 700 rpm
FEED: 30-round box magazine
MUZZLE VELOCITY: 2,410 fps (735 mps)
ORIGINAL COUNTRY OF MANUFACTURE: Soviet Union
FIRST PRODUCED: late 1970s
SUMMARY: This weapon was first reported in Afghanistan late in 1983, though it is thought to have been in service for some time before that. It is a compact version of the AKS 5.45mm assault rifle. It has a combustion chamber near the end of the muzzle for unburned powder, the usual result of firing a cartridge designed for a rifle barrel in a much shorter weapon. The steel butt stock folds sideways and forward to align alongside the receiver.

M249 SAW (LMG)

Courtesy of Art-Tech\Aerospace\M.A.R.S\TRH\Navy Historical.

CALIBER: .223 (5.56mm)
WEIGHT: 15.1 lbs (6.85 kg) with bipod
LENGTH: 40.94" (1040mm)
RATE OF FIRE: 750 rpm
FEED: detachable 30-round box magazine or 200-round metal-link belt
MUZZLE VELOCITY: 2,904 fps (885 mps)
ORIGINAL COUNTRY OF MANUFACTURE: United States
FIRST PRODUCED: 1982
SUMMARY: The M249 Squad Automatic Weapon (SAW) light machine gun is a U.S.-made variant of the Belgian FN Minimi. It is the current standard light machine gun for the U.S. Army and Marine Corps. It has a dual belt\box feed system. It is gas-operated, with a magazine or disintegrating metallic link-belt feed, and fixed headspace and quick-change barrel. When fielded in the mid-1980s, the SAW was issued as a one-for-one replacement for the designated automatic rifle (M16A1) in the fire team. In this regard, the SAW filled the void created by the retirement of the Browning Automatic Rifle during the 1950s because interim automatic weapons (e.g., the M14E2\M16A1) had failed as viable base-of-fire weapons for U.S. infantry rifle squads.

GLOSSARY

action: breech mechanism by which means the gun is cycled.
ammunition: term for the complete round needed to fire a gun.
AP: armor-piercing ammunition.
automatic: a weapon that will fire, reload, and fire as long as the trigger remains pressed and the supply of ammunition is maintained.
ball: term used to describe a normal lead core jacketed bullet for small arms; derived from the early days of firearms when smooth-bore muskets fired actual balls of lead.
barrel: a steel tube in a gun along which the bullet is fired.
belt: cloth or metal link that contains the cartridges for feeding into the weapon's breech.
belt-feed: an automatic weapon in which the ammunition is fed by a flexible belt in which the cartridges are carried.
bipod: a two-legged stand, often attached to the barrel of a machine gun to provide stability during firing.
blowback: a system of operation for self-loading and automatic weapons in which the breech is not locked at the instant of firing and is returned to the rear by the explosion of the cartridge propellant; the breech opens, the spent cartridge is extracted, and the loading cycle is performed.
blow-forward: a system of operation for self-loading and automatic weapons that is analogous to blowback but in which the breechblock remains stationary and the breech pressure blows the barrel forward.
bolt: that part of a small arm that closes the breech and holds the round in the chamber ready for firing; may be mechanically or physically locked or free to move as in a blowback mechanism.
bore: the interior of the gun barrel, extending from the muzzle face to the rear of the chamber.
box magazine: a method of ammunition supply in the form of a metallic or plastic box, either detachable from the weapon or integral to it.
breech: the pressure resistant metal casing surrounding the chamber of a weapon.

breech lock: part of an action that holds or locks the round into the chamber for firing and moves back for ejection of the spent cartridge and loading of the next round.

bullet: the projectile fired from a small arm.

butt\butt stock: on a shoulder arm, the part of the weapon against the firer's shoulder.

caliber: internal dimension of the barrel measured from land to land (the raised portion of rifling inside the bore) or the nominal external diameter of the projectile; see *land*.

cap: portion of the base of the cartridge case that contains the primer

cartridge: a complete round of fixed ammunition.

cartridge case: a metallic or plastic case containing the propellant charge. for a round of ammunition or a blank charge and carrying the means of ignition.

cased telescoped ammunition: a plastic cylindrical cartridge that contains both the bullet and the propellant charge; the cartridge includes a small charge behind the bullet that explodes first, blowing the bullet into the rifling of the barrel. The main charge then fires, propelling the bullet out of the muzzle.

caseless cartridge: a small-arm cartridge that dispenses with the conventional metallic or plastic case and has the propellant formed into a solid mass attached to the bullet.

chamber: the rear portion of the barrel bore that holds the cartridge ready for firing and in which the cartridge is exploded.

change lever: lever usually near the trigger that selects mode of fire; sometimes called selector lever or switch.

closed bolt: weapons that fire from a closed bolt have a round in the chamber before the trigger is pressed.

cocking: the action of mechanically or manually preparing a weapon's mechanism for firing.

cocking handle: projection that is usually attached to the bolt, by which means the action is cocked.

compensator: a muzzle attachment used to direct some portion of the gases escaping from the muzzle upward to counteract a weapon's tendency to rise when fired.

cook-off: the unintentional firing of a round owing to the propellant becoming too hot.

cycle of operation: a term used in connection with small arms and referring to the successive processes involved in firing one shot: feeding, chambering, firing, extraction, ejection, cocking, and storing energy in the return spring; also called the firing cycle.

cyclic rate: the number of rounds per minute (rpm) that an automatic weapon can continuously fire, assuming an unlimited supply of ammunition and no stoppages.

cylinder: the part of a revolver mechanism used to hold rounds ready for firing.

delayed blowback: system of operation used with small arms. The breech of the weapon is not locked, and the breechblock or bolt is driven back by the effect of the cartridge explosion inside the chamber. However, the movement of the block or bolt is resisted by some arrangement, which slows or delays it, keeping the cartridge in the chamber until the pressure has dropped to a safe level.

disintegrating link: a belt of ammunition for an automatic weapon in which the actual rounds of ammunition hold the individual metal links together; when the round has been pulled out of the belt to be loaded into the gun, the link falls free.

drum magazine: a circular magazine into which the rounds are loaded axially or radially and propelled toward the feed lips by a spring or mechanism driven by the gun.

ejection: expelling of an empty case from the body of a weapon.

ejector: part of a gun mechanism that forces the spent cartridge case out of the gun after extraction.

extraction: the withdrawal of an empty case from the chamber.

extractor: part of a gun mechanism, usually on a bolt or breech lock, that withdraws the cartridge case from the chamber.

feed: that portion of the firing cycle of a weapon in which the cartridge is removed from the ammunition supply and loaded into the chamber.

feed tray: area of the receiver of a belt-fed automatic weapon across which the belt is laid and where the cartridge is separated from the belt and delivered to the feedway.

feedway: the area of the weapon mechanism in which the cartridge is removed from the ammunition supply and aligned before loading into the chamber.

firing pin: part of the firing mechanism that actually strikes the primer to fire the gun.

flash hider: device fixed to the muzzle to hide the flash produced when firing; also known as a flash suppressor.

flexible gun: on an aircraft or armored fighting vehicle, a gun that can be traversed by the operator.

gas piston: an internal rod inside the gas tube that imparts movement to the bolt or associated components.

gas port: on the barrel, the port from which gas is bled into the gas take-off system.

gas tube: lies parallel with the barrel and imparts gas drawn from the barrel gas take-off port; usually houses the gas piston and spring.

GPMG: general-purpose machine gun; an automatic weapon capable of being adapted to either the light or medium machine gun roles.

HMG: heavy machine gun; usually implies a caliber of 12.7mm\.50-inch or greater.

jam: a loose term for a stoppage caused by an object, usually a round or cartridge case, becoming jammed or fouled inside a weapon.

land: raised portion of rifling inside the bore.

LMG: light machine gun; generally used to describe the infantry squad automatic weapon; a machine gun capable of being carried and operated by one man.

magazine: device used on small arms to hold rounds ready for loading and firing; usually detachable; may be either box-type or drum-type.

MMG: medium machine gun; obsolescent term referring to rifle-caliber machine guns used in sustained-fire support role.

muzzle velocity: speed of a bullet as it leaves the muzzle.

open bolt: weapons that fire from an open bolt have the working parts to the rear and no round in the chamber when the trigger is pressed.

Parabellum: certain cartridges and weapons that were developed by the Deutche Waffen & Munitionsfabrik of Germany in the early years of the twentieth century.

primer: a small charge in the base of a cartridge that fires the main propellant.

propellant: the explosive charge inside a cartridge that propels the bullet.

prototype: an experimental or preproduction model.

range: the distance to which a bullet can be fired; usually defined as maximum effective, which is the range at which the bullet will still have a useful striking power.

rate of fire: number of rounds fired per minute; the cyclic rate is that possible in one minute if an uninterrupted supply of ammunition is maintained; the practical rate includes the time lost for changing magazines, etc.

receiver: part of weapon containing the bolt\breechblock and mainspring; sometimes known as the body.

recoil: the rearward movement of a gun or other firearm due to reaction to the ejection of the propellant from the muzzle.

return spring: a spring in an automatic or self-loading weapon that is compressed by the recoiling bolt and that then drives the bolt forward to reload and recommence the cycle of operation.

rifling: grooves cut inside a barrel to impart stabilizing spin to a bullet.

round: general term used to denote a complete item of ammunition, comprising all the components necessary for one effective shot: cap, cartridge case, propellant charge, and projectile.

rpm: rounds per minute; usually a cyclic rate of fire.

self-loading: weapon that automatically reloads on firing without the firer having to take any action.

semiautomatic: term applied to small-arm that fires once, ejects spent case, reloads but does not fire again until the tripper is pressed.

SMG: submachine gun; a short-barreled, automatic, magazine-fed weapon that is used for close-quarters fighting.

stock: part of a small arm held by the firer and used to aim the weapon.

tracer: ammunition in which the projectile is ignited and glows in flight to indicate direction of fire and for aiming.

trajectory: the flight path of a projectile between the muzzle and the target
trigger: lever operated manually to fire a weapon.
tripod: three-legged mount, usually separate from the gun; an accessory or auxiliary equipment, designed for fixed line fire or antiaircraft application.
zeroing: the adjustment of the sights of a weapon so as to move the mean point of impact of a group of shots to the correct position in relation to the point of aim.

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